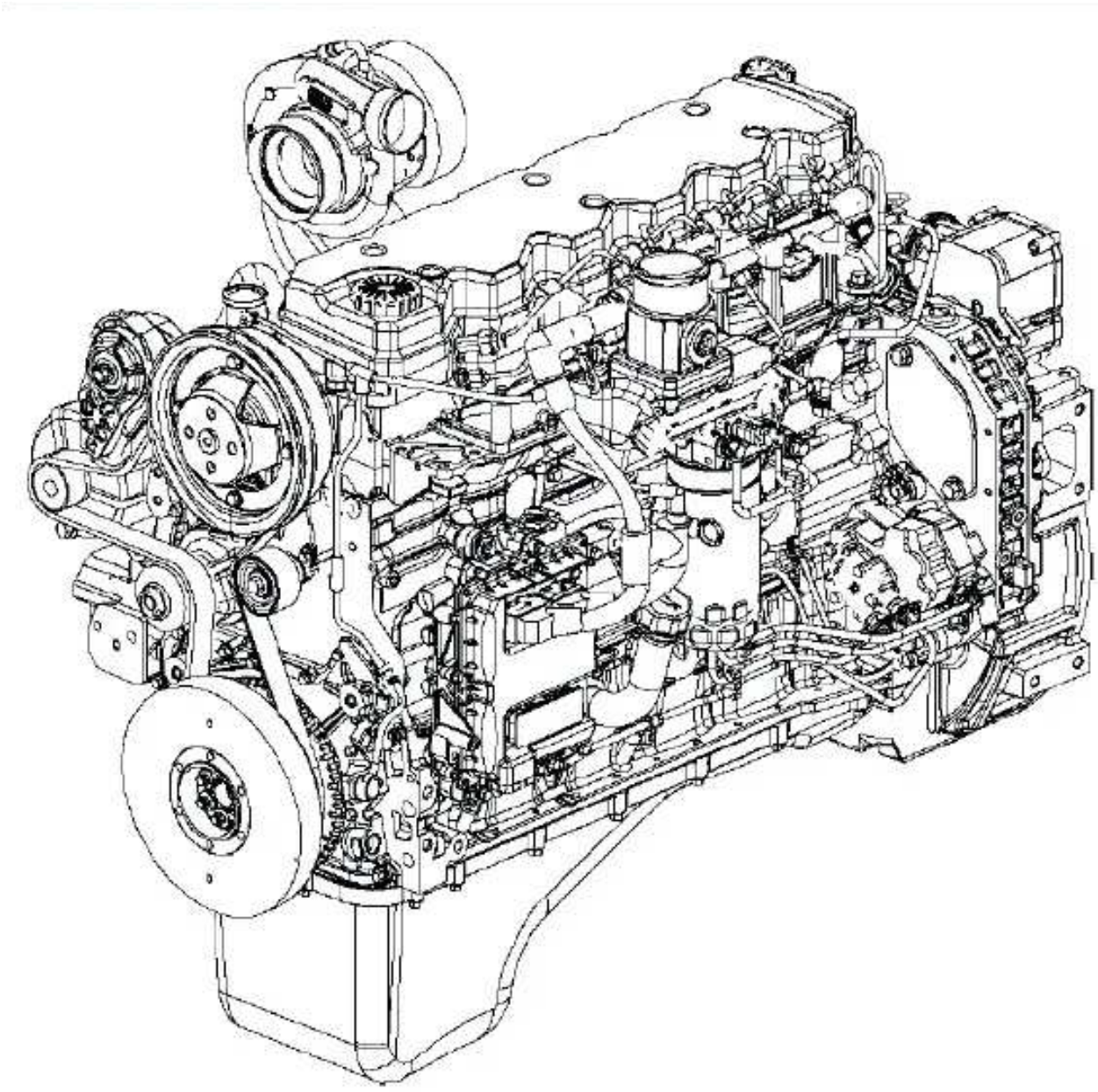
NEF 445TA and 667TA TIER 3 Electronic Engines



NEF TIER 3 ELECTRONIC ENGINE

Notes

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NEF TIER 3 ELECTRONIC ENGINE

CASE NEF ENGINE EC HART

	The Number in ( ) = the number of Cylinders Last two numbers = Engine Displacement	Valves per cylinder	Aspiration	Mechanical vs. Electronic	EGR vs. Non EGR	Emission level	Biodiesel Blend Level AC = Approved - must follow Case Guidelines for Biodiesel Blends above 5% AC-HP = Approved - must follow Case HPCR Engine Guidelines for Biodiesel Blends above 5% NA = Not Approved	
Skid Steers							5%	20%
430	(4) 4.5L	2	Natural	Mechanical	Non EGR	Tier 2	Approved	AC
435	(3) 3.4L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
440 440CT	(4) 4.5L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
440I 440CT III	(4) 4.5L	2	Turbo	Mechanical	Internal	Tier 3	Approved	AC
445 445CT	(4) 4.5L	2	Natural	Mechanical	Non EGR	Tier 2	Approved	AC
450 450CT	(4) 4.5L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
450I 450CT III	(4) 4.5L	2	Turbo	Mechanical	Internal	Tier 3	Approved	AC
465	(4) 4.5L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
465I	(4) 4.5L	2	Turbo	Mechanical	Internal	Tier 3	Approved	AC

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CASE NEF ENGINE EC HART								
	The Number in ( ) = the number of Cylinders Last two numbers = Engine Displacement	Valves per cylinder	Aspiration	Mechanical vs. Electronic	EGR vs. Non EGR	Emission level	Biodiesel Blend Level AC = Approved - must follow Case Guidelines for Biodiesel Blends above 5% AC-H = Approved - must follow Case HPCR Engine Guidelines for Biodiesel Blends above 5% NA = Not Approved	
Loader Backhoes							5%	20%
580M II	(4) 4.5L	2	Natural	Mechanical	Non EGR	Tier 2	Approved	AC
580M Turbo II	(4) 4.5L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
580M Turbo III	(4) 4.5L	2	Turbo	Mechanical	Internal	Tier 3	Approved	AC
580SM II	(4) 4.5L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
580SM + II	(4) 4.5L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
580SM III	(4) 4.5L	4	Turbo	Electronic	Internal EGR	Tier 3	Approved	AC-H
580SM + III	(4) 4.5L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H
590SM II	(4) 4.5L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
590SM III 590SM + III	(4) 4.5L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H
Loader Tool Carrier								
570M XT III	(4) 4.5L	2	Turbo	Mechanical	Internal	Tier 3	Approved	AC

CASE NEF ENGINE CHART

	The Number in ( ) = the number of Cylinders Last two numbers = Engine Displacement	Valves per cylinder	Aspiration	Mechanical vs. Electronic	EGR vs. Non EGR	Emission level	Biodiesel Blend Level AC = Approved – must follow Case Guidelines for Biodiesel Blends above 5% AC-H = Approved – must follow Case HPCR Engine Guidelines for Biodiesel Blends above 5% NA = Not Approved	
Wheel Loaders							5%	20%
521D	(4) 4.5L	2	Turbo After Cooler	Mechanical	Non EGR	Tier 2	Approved	AC
521E	(4) 4.5L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H
621D	(6) 6.7L	2	Turbo After Cooler	Mechanical	Non EGR	Tier 2	Approved	AC
621E	(6) 6.7L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H
721D	(6) 6.7L	4	Turbo After Cooler	Electronic	Non EGR	Tier 2	Approved	AC-H
721E	(6) 6.7L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H
821E	(6) 6.7L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H

CASE NEF ENGINE EC HART

	The Number in ( ) = the number of Cylinders Last two numbers = Engine Displacement	Valves per cylinder	Aspiration	Mechanical vs. Electronic	EGR vs. Non EGR	Emission level	Biodiesel Blend Level AC = Approved - must follow Case Guidelines for Biodiesel Blends above 5% AC-H = Approved - must follow Case HPCR Engine Guidelines for Biodiesel Blends above 5% NA = Not Approved	
Crawlers							5%	20%
650K 50K II/III	(4) 4.5L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
750L	(4) 4.5L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H
850K I/III	(6) 6.7L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
850L	(6) 6.7L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H
1150K III	(6) 6.7L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H
1650L	(6) 6.7L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H
1850K III and 1850K III LGP	(6) 6.7L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H

NEW HOLLAND NEF ENGINE CHART

	The Number in ( ) = the number of Cylinders Last two numbers = Engine Displacement	Valves per cylinder	Aspiration	Mechanical vs. Electronic	EGR vs. Non EGR	Emission level	Biodiesel Blend Level ACA = Approved - must follow Case Guidelines for Biodiesel Blend above 5% ACH = Approved - must follow Case HPCR Engine Guidelines for Biodiesel Blend above 5% NA = Not Approved	
Skid Steers							5%	20%
LS190.B	(3) 3.4L	2	Natural	Mechanical	Non EGR	Tier 2	Approved	ACA
L180 Before Ser. # N8M6 4426	(3) 3.4L	2	Natural	Mechanical	Non EGR	Tier 3	Approved	ACA
-LS180.B -C185 Before Ser. N8M6 5249	(3) 3.4L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	ACA
L185 Before Ser. # N846 247	(3) 3.4L	2	Turbo	Mechanical	Internal	Tier 3	Approved	ACA
-LS190.B -L190 Before Ser. # N7M5 9487 -C190	(4) 4.5L	2	Natural	Mechanical	Non EGR	Tier 2	Approved	ACA
L190 C190 After Ser. # N7M5 9487	(4) 4.5L	2	Turbo	Mechanical	Internal	Tier 3	Approved	ACA

NEW HOLLAND NEF ENGINE CHART								
	The Number in ( ) = the number of Cylinders Last two numbers = Engine Displacement	Valves per cylinder	Aspiration	Mechanical vs. Electronic	EGR vs. Non EGR	Emission level	Biodiesel Blend Level AC = Approved - must follow Case Guidelines for Biodiesel Blends above 5% AC-H = Approved - must follow Case HPCR Engine Guidelines for Biodiesel Blends above 5% NA = Not Approved	
Loader Backhoes							5%	20%
LB75B LB90B LB100.B LB150.B	(4) 4.5L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
B90B	(4) 4.5L	2	Turbo After Cooler	Mechanical	Internal	Tier 3	A	AC
B95 B95R B95TC	(4) 4.5L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
B95B B95B R B95B C	(4) 4.5L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H
B110 B115	(4) 4.5L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
B115B B115	(4) 4.5L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H
Tractor Loader								
U80	(4) 4.5L	2	Turbo	Mechanical	Internal	Tier 3	Approved	AC

NEW HOLLAND NEF ENGINE CHART

	The Number in ( ) = the number of Cylinders Last two numbers = Engine Displacement	Valves per cylinder	Aspiration	Mechanical vs. Electronic	EGR vs. Non EGR	Emission level	Biodiesel Blend Level AC = Approved – must follow Case Guidelines for Biodiesel Blends above 5% AC-H = Approved – must follow Case HPCR Engine Guidelines for Biodiesel Blends above 5% NA = Not Approved	
Wheel Loaders							5%	20%
W110 LW110.B	(4) 4.5L	2	Turbo After Cooler	Mechanical	Non EGR	Tier 2	Approved	AC
W118	(4) 4.5L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H
W130	(6) 6.7.L	2	Turbo After Cooler	Mechanical	Non EGR	Tier 2	Approved	AC
LW190.B	(6) 5.9L	2	Turbo After Cooler	Electronic	??????	????	????	????
LW190.B LW170.B	(6) 6.7L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H
W138 W178 W198	(6) 6.7L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H

NEW HOLLAND NEF ENGINE CHART								
	The Number in ( ) = the number of Cylinders Last two numbers = Engine Displacement	Valves per cylinder	Aspiration	Mechanical vs. Electronic	EGR vs. Non EGR	Emission level	Biodiesel Blend Level AC =Approved - must follow Case Guidelines for Biodiesel Blends above 5% AC-H= Approved - must follow Case HPCR Engine Guidelines for Biodiesel Blends above 5% NA =Not Approved	
Crawlers							5%	20%
D75 D85	(4) 4.5L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
D95	(6) 6.7L	2	Turbo	Mechanical	Non EGR	Tier 2	Approved	AC
D85B D95B	(4) 4.5L	4	Turbo After Cooler	Electronic	Internal EGR	Tier 3	Approved	AC-H

NEW HOLLAND NEF ENGINE CHART								
	The Number in ( ) = the number of Cylinders Last two numbers = Engine Displacement	Valves per cylinder	Aspiration	Mechanical vs. Electronic	EGR vs. Non EGR	Emission level	Biodiesel Blend Level AC =Approved - must follow Case Guidelines for Biodiesel Blends above 5% AC-H= Approved - must follow Case HPCR Engine Guidelines for Biodiesel Blends above 5% NA =Not Approved	
Excavator							5%	20%
E175B	(4) 4.5L	2	Turbo After Cooler	Mechanical	Internal	Tier 3	Approved	AC
E215B	(6) 6.7L	2	Turbo	Mechanical	Internal	Tier 3	Approved	AC

Notes

Engines Introduction

Some of the features of the electronic engine are:

- Bosch electronic fuel injection – common rail
- Selectable power modes
- On board diagnostics
- Electronic throttle control – variable idle
- Larger grid heater
- Advanced camshaft design for improved emissions
- Non waste-gate turbocharger
- Upgraded Electronic Diesel Engine Controller
- Redesigned pistons
- Four valves per cylinder
- Parent metal bore engine block
- Integral engine oil cooler
- Integral water pump

Coding of Source Engines (6 Cylinder)

6	6	7	T	A	E	D	J
							Engine Calibration (Power) (D) J= 97 kW (130 H.P.) (E) G= 137 kW (183.7 H.P.) (E) D= 145 kW (194.4 H.P.) (E) C= 148 kW (198.5 H.P.) (B) F= 157 kW (210.5 H.P.) (B) D= 169kW (226.6 H.P.)
						Compression Ratio B = 16.5:1>130 kW (174 H.P.) D = 17.5:1 <= 130 kW (174 H.P.) E =17.5:1 > 130kW (174 H.P.)	
					E= Electronic Injection (Common Rail)		
				A= Intercooled			
			T= Turbocharged				
		67= Total Displacement in Liters/ Cubic Inches- 6.7 Liters (409 Cubic Inches)					
6= Number of Cylinders							

NEF TIER 3 ELECTRONIC ENGINE

Engine Properties

4 Cylinder Engines

A	F4GE9454H	F4GE9454H	F4GE9454J	F4GE9454J	F4GE9484D	F4GE9484D	F4HE9484A	F4HE9484C
B	*J601	*J602	*J600	*J601	*J601	*J602	* J101	*J101/*J102
C	4 Cylinders							
D	4485 cm³ (273.7 cubic inches)							
E	74 kW (100 h.p.) 2000 rpm	74 kW (100 h.p.) 2000 rpm	66 kW (90 h.p.) 2000 rpm	66 kW (90 h.p.) 2000 rpm	93 kW (126 h.p.) 2200 rpm	93 kW (126 h.p.) 2200 rpm	104 kW (141 h.p.) 2200 rpm	82 kW (110 h.p.) 2200 rpm
F	Direct Injection							
G	Rotary Injection pump						High pressure Common rail EDC7UC31	
H	T.C. (Boosted)				T.A.A.- (Boosted by Intercooler)			

A. Type of engine
B. Engine model
C. Number of cylinders
D. Total displacement
E. Maximum power currently available
F. Type of Injection
G. Injection system
H. Air supply system

6 Cylinder Engines

A	667TA	667TA	667TA	667TA	667TA	667TA
B	EEG	EEC	EBF	EED	EBD	EDJ
C	6 CYLINDERS					
D	6728 cm³ (410.6 c.i.)					
E	137 kW (183.7 h.p.) 2100 rpm	148 kW (198.5 h.p.) 2100 rpm	157kW (210.5 h.p.) 2000 rpm	145kW (194.4 h.p.) 2000 rpm	169 kW (226.6 h.p.) 2000 rpm	97 kW (130.1 h.p.) 2200 rpm
F	Electronic Direct Injection					
G	Common Rail					
H	T.A.A. (Turbo Charged, Air to Air Cooling)					

A. Type of engine
B. Engine model
C. Number of cylinders
D. Total displacement
E. Maximum power currently available
F. Type of Injection
G. Injection system
H. Air supply system

Engine Identification Code

F 4 A E 0 6 8 4 F E 1

Engine family Includes 4 Cyl & 6 Cyl in both 2 valves & 4 valves per cylinder Mechanical and Common Rail fuel systems

Engine

Cylinder orientation:
0 = 4 strokes vertical

No. Cylinders
4 = 4 cylinders
6 = 6 cylinders

Fuel / injection / Induction
0 = Diesel Injection – Nat Aspirated
5 = Diesel Injection – Turbo
8 = Diesel Injection – Turbo - Aftercooler

Application
4 = Agric. mach. – Earthmoving

Approved power rating

Emissions level
D =Tier 2, E =Tier 3

1= Common Rail 4 valve
2 = Common Rail 2 Valve
3 = In-Line 4 Valve
4 = In-Line 2 Valve
5 = Rotary 4 valve
6 = Rotary 2 Valve

Engine crankcase type: Block Type - Bore – No. Valves - Displacement

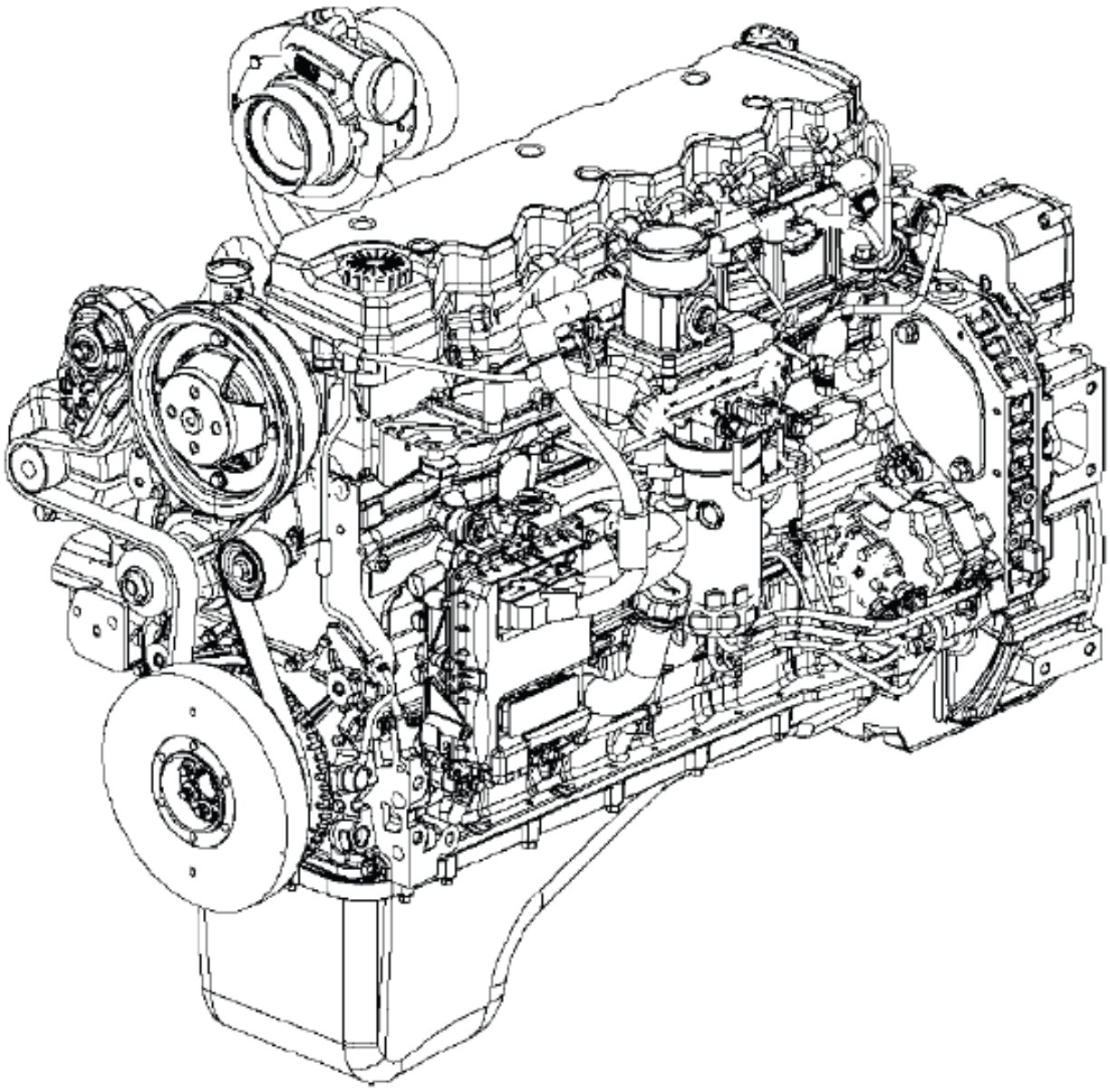
A = Non-structural crankcase 102 mm - 4 valves – 3.9 or 5.9 Liter
B = Non-structural crankcase 102 mm - 2 valves– 3.9 or 5.9 Liter
C = Structural crankcase 104 mm - 2 valves – 4.5 or 6.8 Liter
D = Structural crankcase 104 mm - 4 valves – 4.5 or 6.8 Liter
E = Structural crankcase 102 mm - 4 valves – 3.9 or 5.9 Liter
F = Structural crankcase 102 mm - 2 valves– 3.9 or 5.9 Liter
G = Non-Structural crankcase 104 mm - 2 valves – 4.5 or 6.8 Liter
H = Non-structural crankcase 104 mm - 4 valves – 4.5 or 6.8 Liter

Mechanical injection = 2 valves
Electronic injection = 4 valves

NEF TIER 3 ELECTRONIC ENGINE

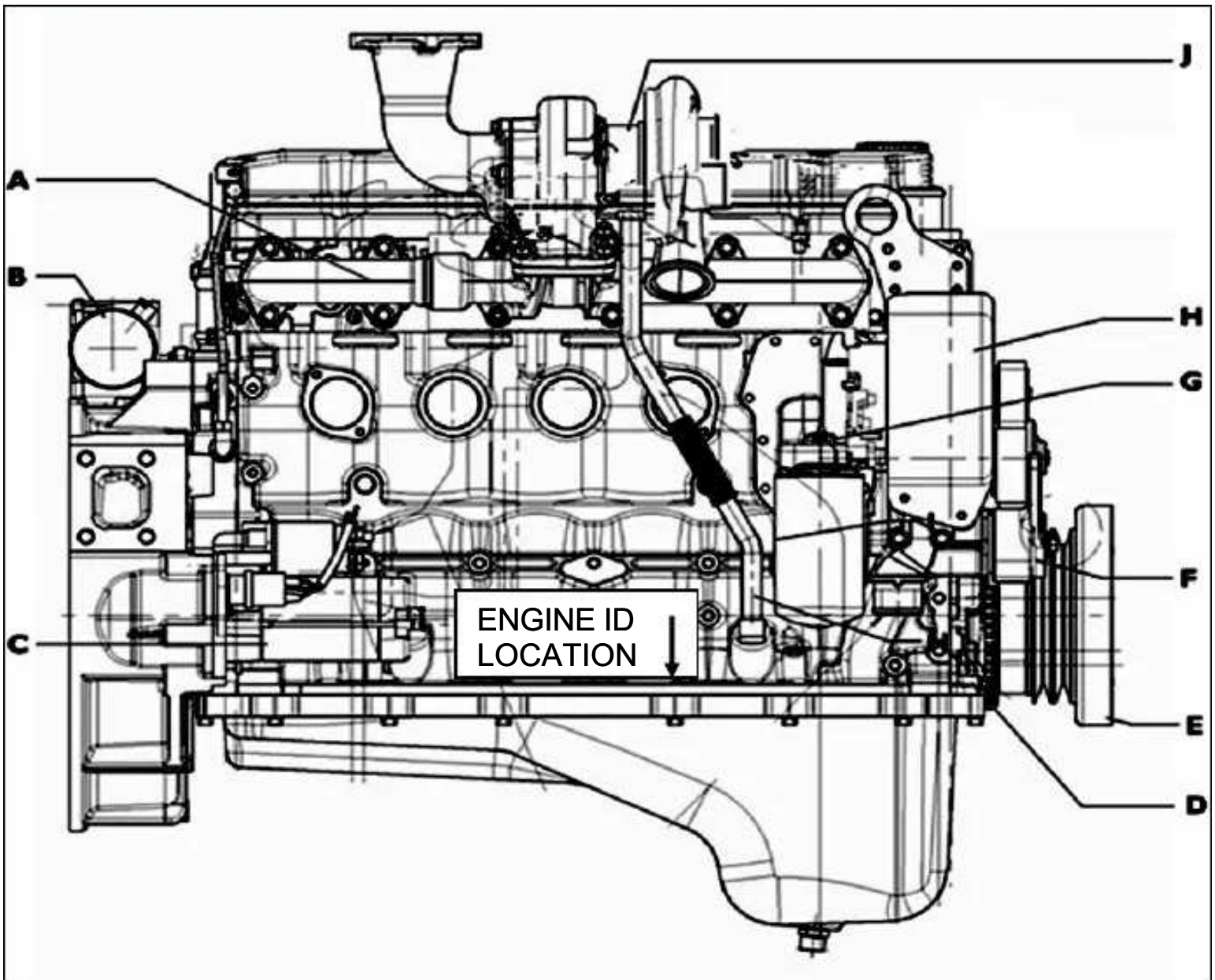
General Information: Engine F4

The F4 family of engine is also known as a NEF engine. This engine offers high ruggedness, power, efficiency, reliability and durability as well as complies with emissions standards and the regulations defining permissible noise levels. It incorporates an electronically controlled high pressure injection system (common rail); cylinder head with four valves per cylinder, intake / exhaust manifolds that improve the dynamic flow of air and exhaust gas, and pistons with revised geometry of the combustion chamber.



Engine Walk Around

Right side view



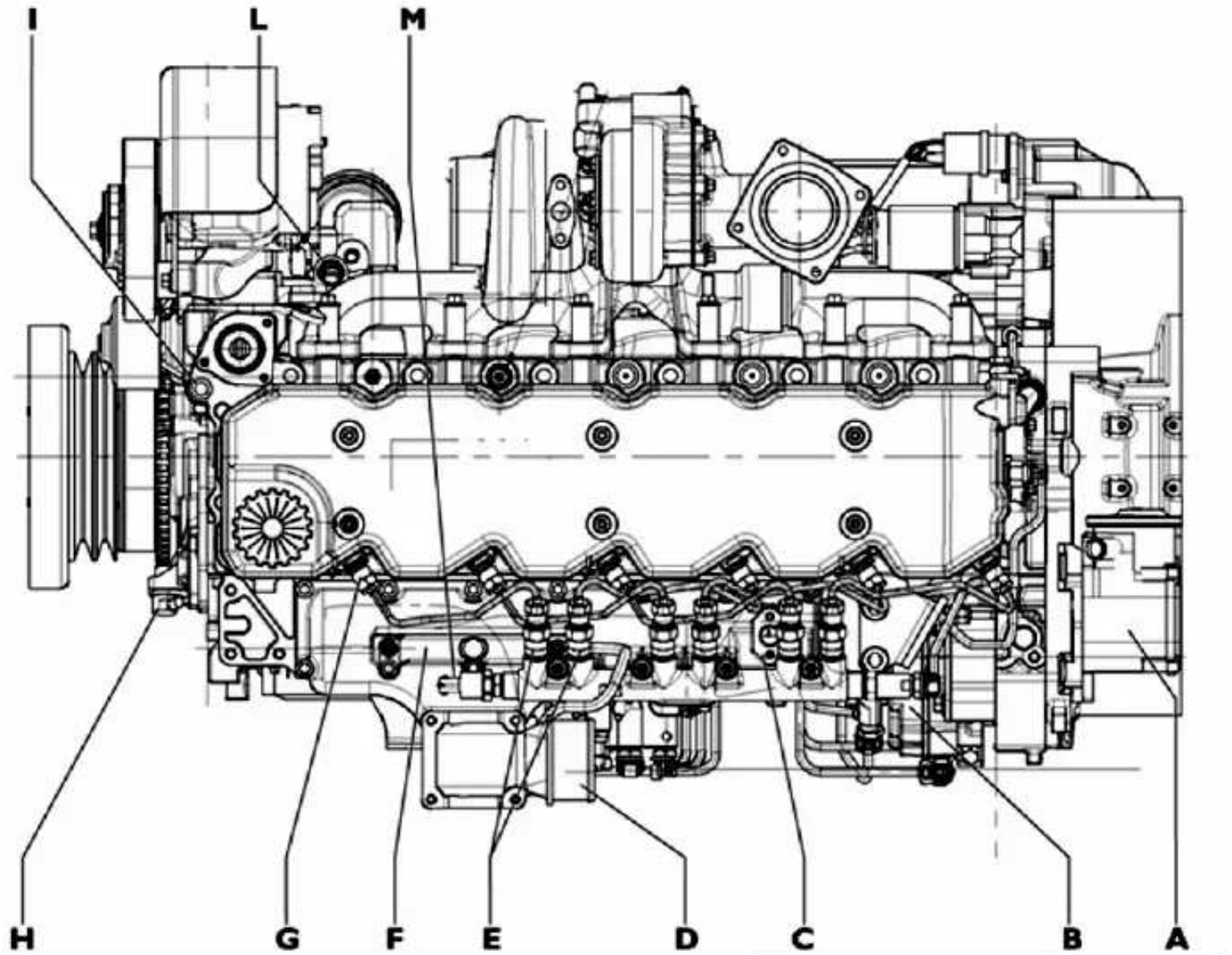
F4AE0684F ENGINE

Right side view legend

A. Exhaust manifold
B. Blow – by filter
C. Starter motor
D. Crankshaft speed sensor wheel
E. Vibration damper
F. Automatic belt tensioner
G. Oil pressure and temperature sensor
H. Alternator
J. Turbocharger

NEF TIER 3 ELECTRONIC ENGINE

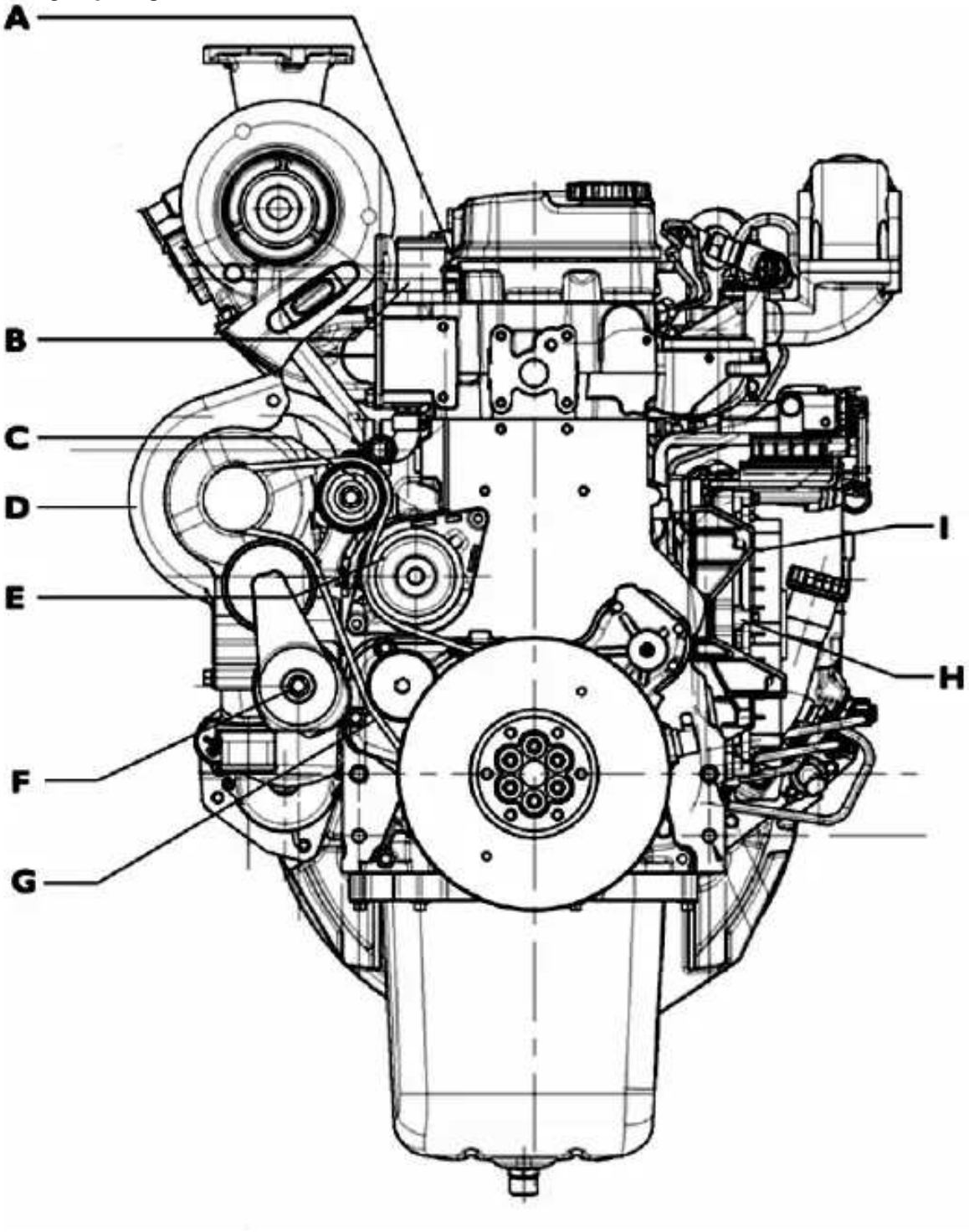
Top view



Top view legend

A. Blow – by Filter
B. Common Rail overpressure valve
C. Intake Air pressure and temperature sensor
D. Intake manifold
E. Flow limiters (1 for each cylinder) – Not used
F. Intake Air heater
G. Electro-injectors power connectors
H. Crankshaft sensor
I Coolant temperature sensor
L. Oil pressure and temperature sensor
M. Common Rail pressure sensor

Front view

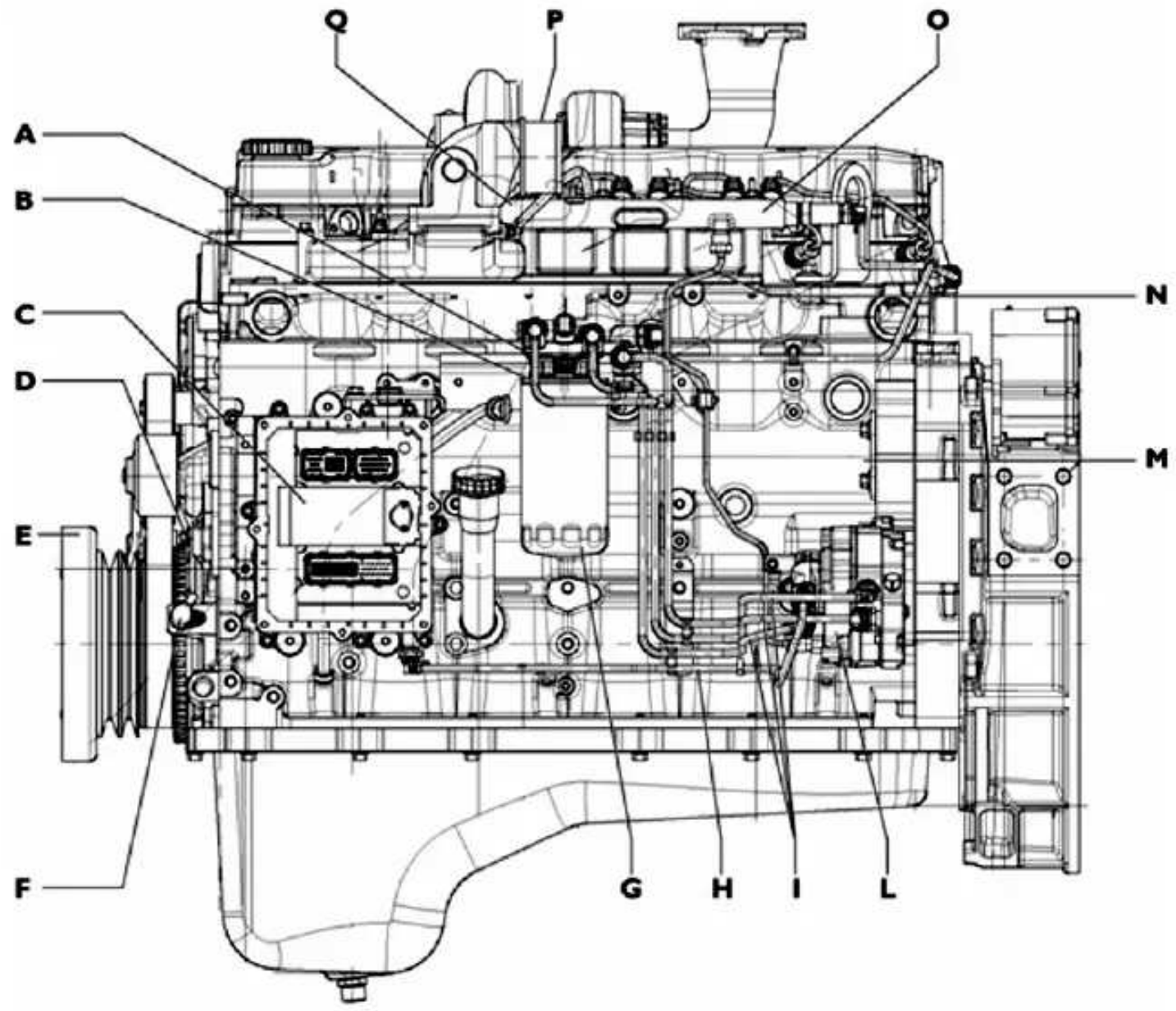


Front view legend

A. Coolant temperature sensor
B. Thermostat
C. Fixed guide pulley
D. Alternator
E. Water pump
F. Automatic belt tensioner
G. Poly-V belt driving: water pump, alternator
H. Electronic control unit heat exchanger
I. Electronic control unit

NEF TIER 3 ELECTRONIC ENGINE

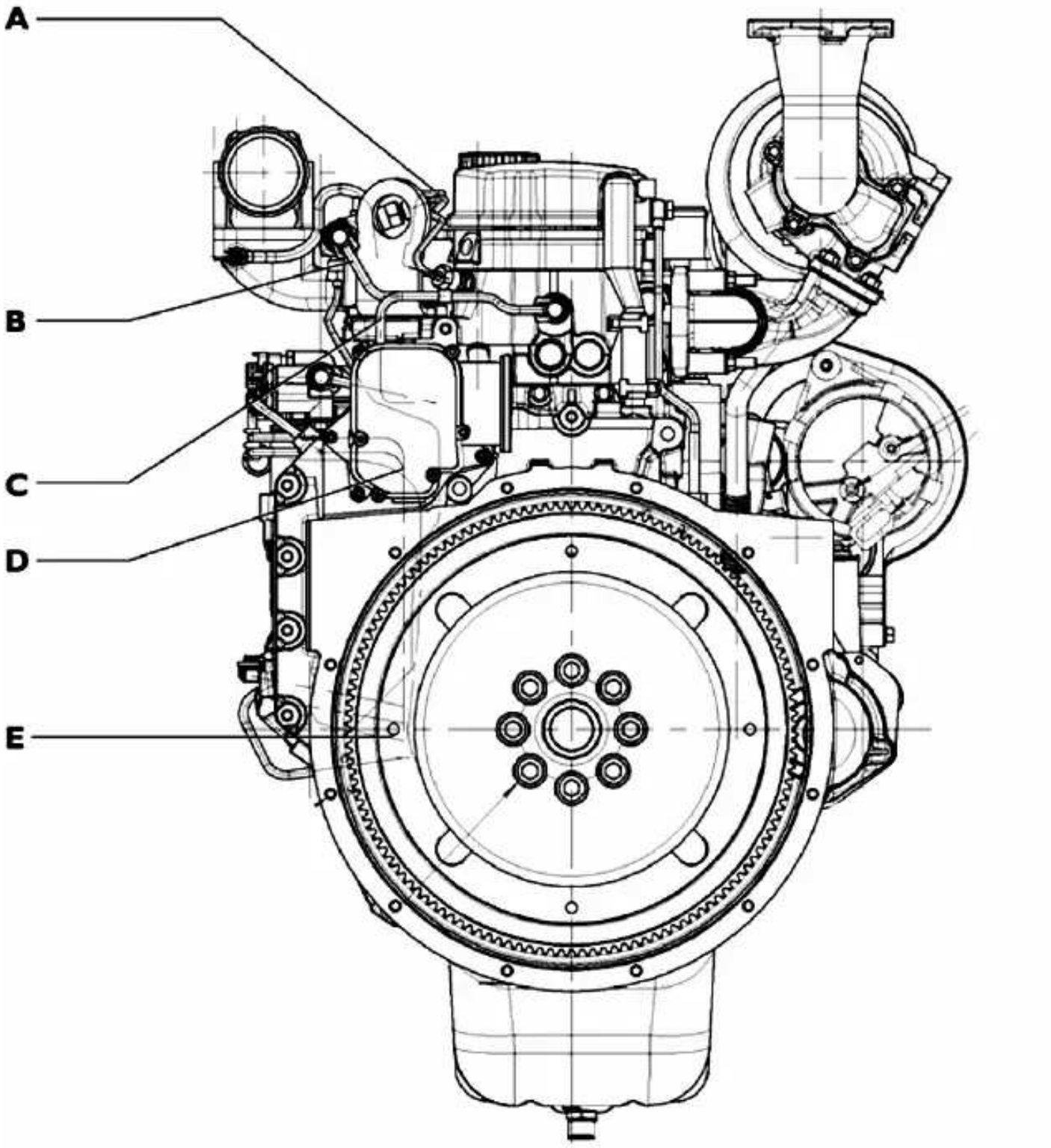
Left side view



Left side view legend

A. Fuel filter support with fuel temperature sensor
B. Fuel heater
C. Electronic control unit with fuel heat exchanger
D. Crankshaft speed sensor wheel
E. Vibration damper
F. Crankshaft sensor
G. Fuel filter
H. Mechanical fuel pump feeding pipe
I. Low pressure pipes
L. High pressure pump with feed pump
M. Camshaft sensor
N. High pressure pipe (To Common Rail)
O. Common Rail
P. Intake manifold with heater and air pressure and temperature sensor
Q. Common Rail pressure sensor

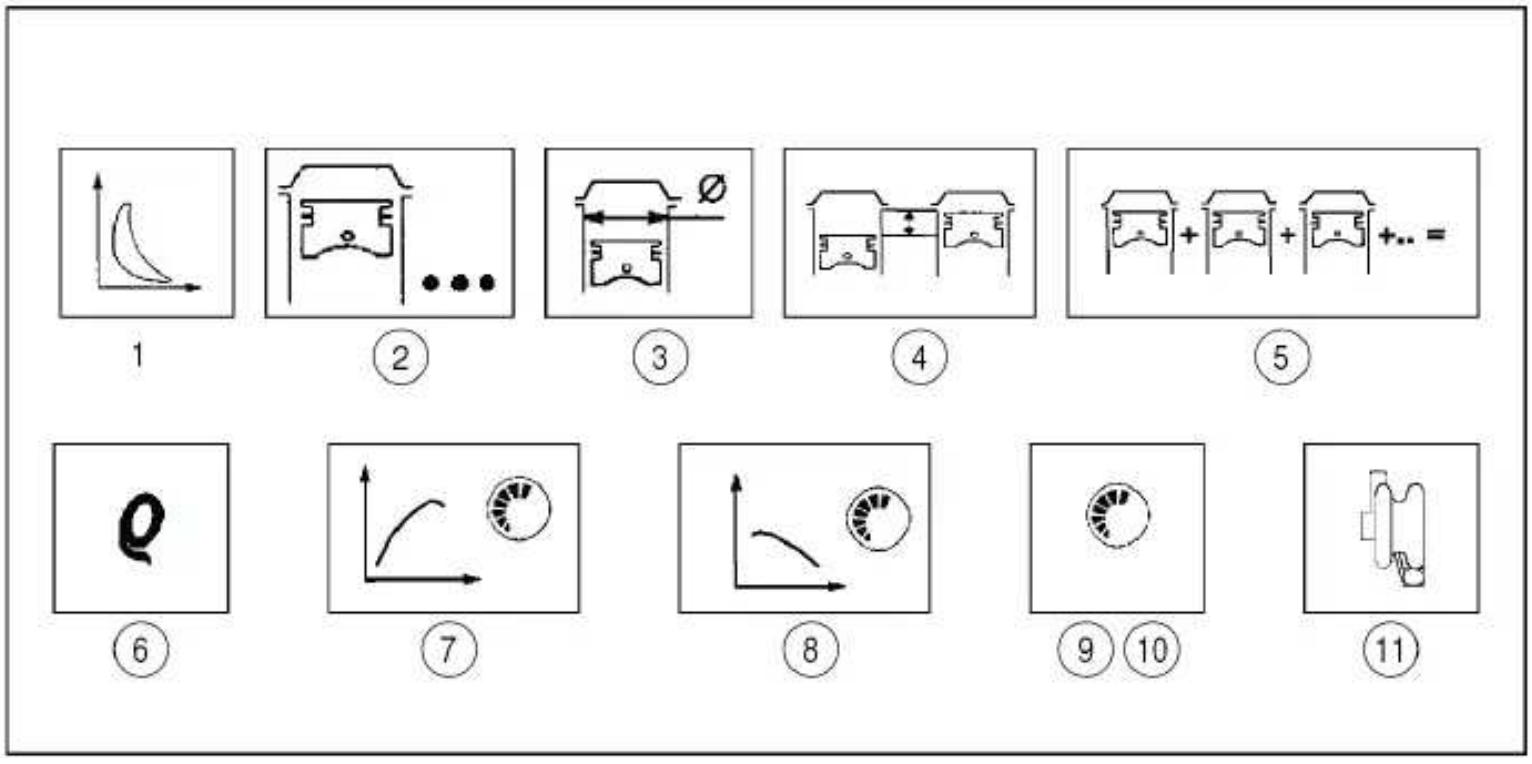
Rear view



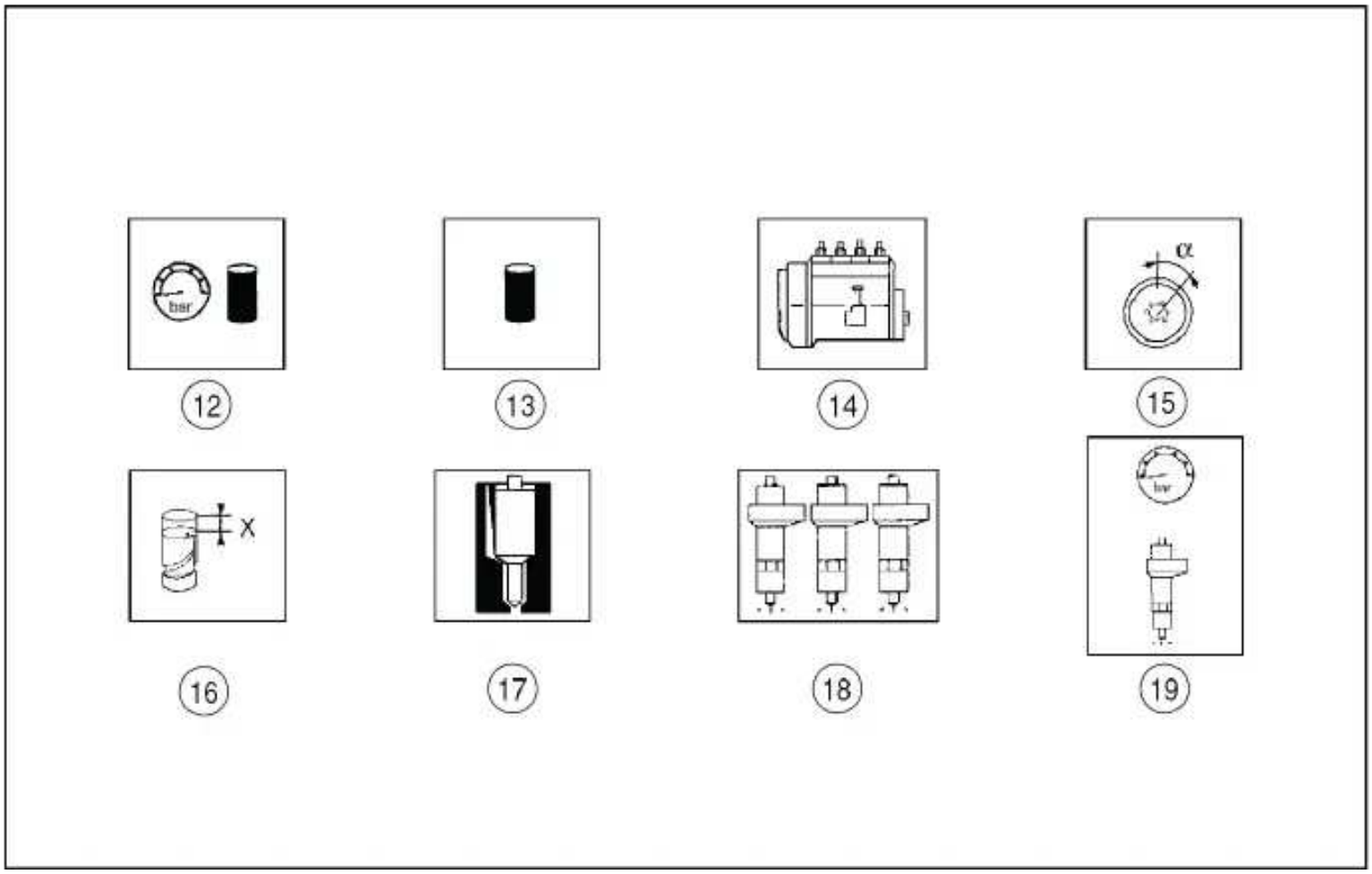
Rear view legend

A. High pressure pipe feeding electro-injectors
B. Fuel discharge pipe from Common Rail overpressure valve
C. Fuel drain pipe from electro-injectors
D. Blow–by filter
E. Engine flywheel

General F4 (4 Cylinder) Engine Features

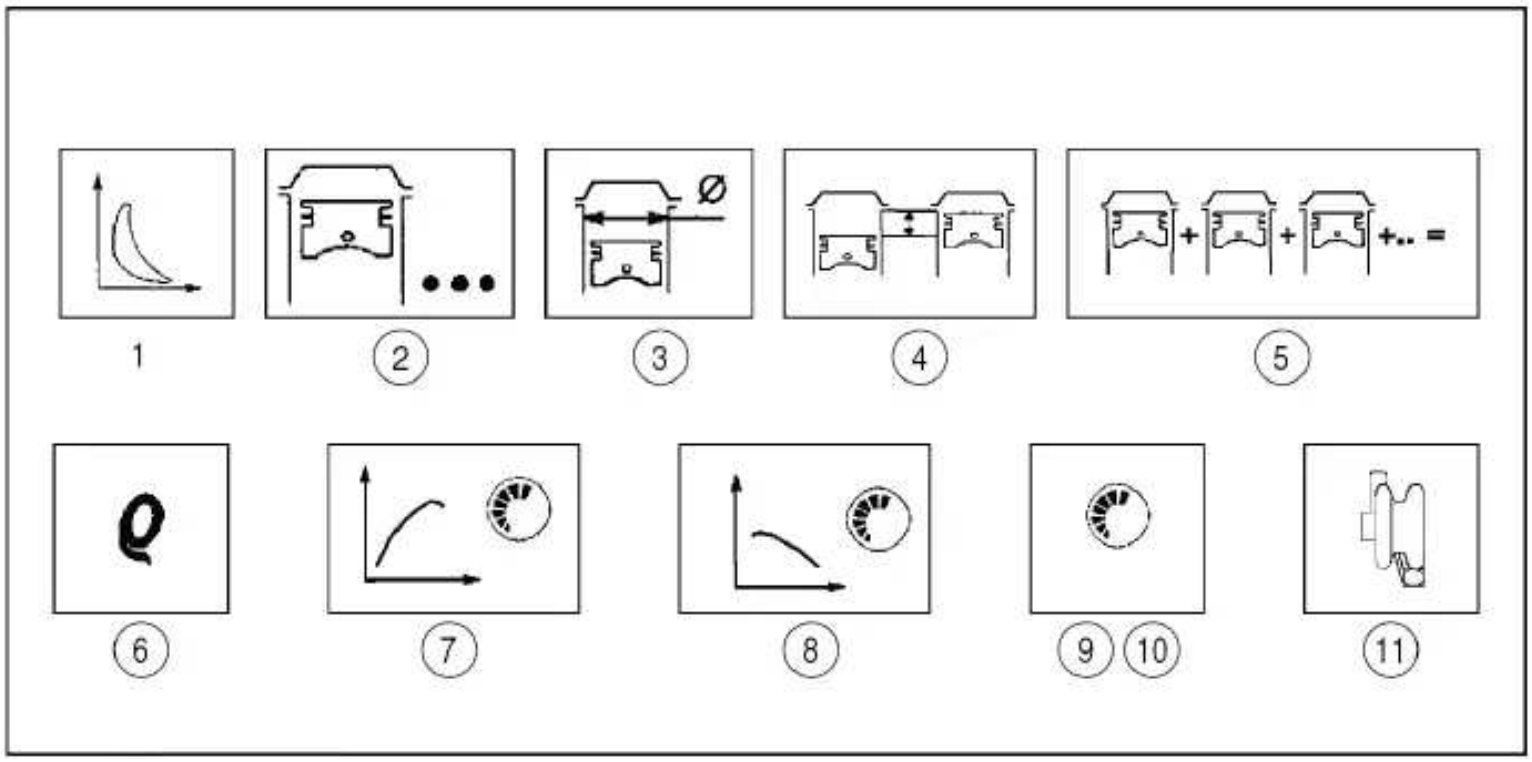


REF. NO.	ENGINE TYPE	F4GE9454H		F4GE9454J		F4GE9484D		F4HE9484A	F4HE9484C
		J601	J602	J600	J601	J601	J602	J101	J101 / J102
1	Cycle	4- Stroke diesel engine							
	Air	Boosted				Boosted by intercooler			
	Injection	Direct							
2	Number of cylinders	4 in-line							
3	Bore	104 mm (4.1 in.)							
4	Stroke	132 mm (5.2 in)							
5	Total displacement	4485cm³ (273.7 cubic inches)							
6	Compression ratio	17.5: 1						16.5: 1	17.5: 1
7	Maximum power rating (net power at flywheel ISO 14396)	74 kW @ 2000 rpm		66 kW @ 2000 rpm		93 kW @ 2200 rpm		104 kW @ 2200 rpm	82 kw @ 2200 rpm
		100 hp @ 2000 rpm		90 hp @ 2000 rpm		126 hp @ 2200 rpm		141 hp @ 2200 rpm	110 hp @ 2200 rpm
8	Maximum Torque	400 Nm @ 1250 rpm		375 Nm @ 1250 rpm		510 Nm @ 1250 rpm		608 Nm @ 1600 rpm	516 Nm @ 1400 rpm
		295 lb.-ft. @ 1250 rpm		277 lb.-ft. @ 1250 rpm		376 lb.- ft. @ 1250 rpm		448 lb.-ft. @ 1600 rpm	381 lb. - ft. @ 1400 rpm
9	No-load idle					950 rpm			
10	No-load peak rpm					2430 rpm			
11	Boosting (type of turbocharger)	Without intercooler HOLSET HX25				With intercooler HOLSET HX25		With intercooler HOLSET HX27W	???

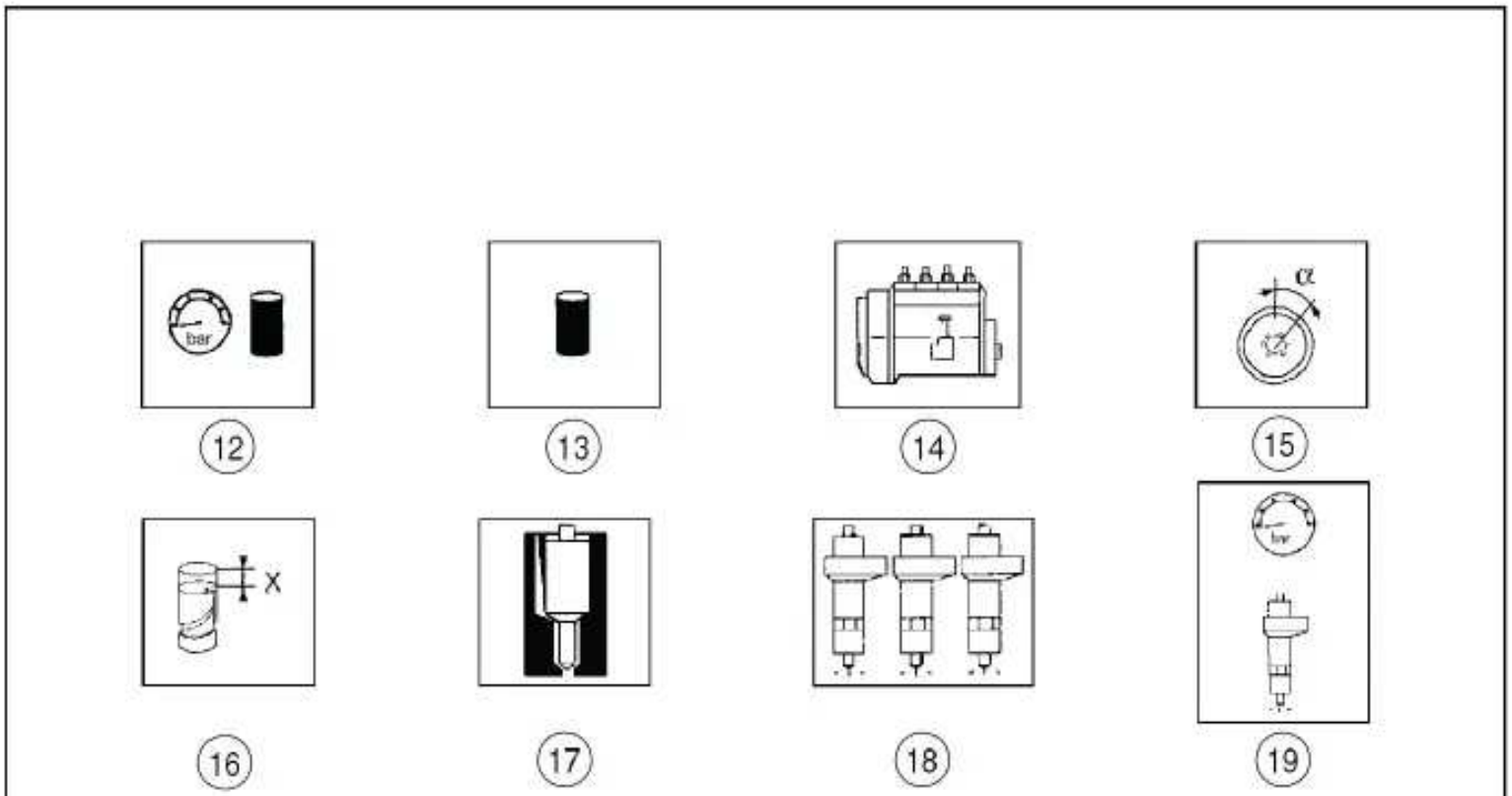


REF. NO.	ENGINE TYPE	F4GE9454H		F4GE9454J		F4GE9484D		F4HE9484A	F4HE9494C
		J601	J602	J600	J601	J601	J602	J101	J101 / J102
12	Lubrication.	Forced by means of gear pump, pressure relief valve, oil filter.							
	Oil pressure with hot engine: at idle rpm.	0.70 bar (10 psi)							
	Oil pressure with hot engine: at peak rpm.	3.50 bar (50 psi)						4.0 bar (58 psi)	
13	Cooling.	By centrifugal pump, regulated by thermostat, heat exchanger, intercooler							
	Water pump drive.	By means of Belt							
	Thermostat start of opening temperature.	79 to 83° C (174 to 181° F)							
14	Oil capacity engine sump.	Refer to Owners Manual							
	Oil capacity engine sump + filter.	Refer to Owners Manual							
15	Fuel feed type	Rotary Bosch - VE4 / 12 F						High Pressure Common Rail, EDC7UC31	
16	Pump setting	0° ± 0.5°						N.A.	
17	Start of delivery	0.95 to 1.05 mm (0.0374 to 0.0413 in.)						N.A.	
	Type of injector	No information available						CRIU 2	
18	Injection sequence	1 -3 -4 -2							
19	Injection pressure	N.A.						250 to 1600 bar	
								3626 to 23206 psi	

General F4 (6 Cylinder) Engine Features



REF. NO.	ENGINE TYPE	667TA					
		EEG	EEC	EBF	EED	EBD	EDJ
1	Cycle	4- Stroke diesel engine					
	Feeding	Boosted by intercooler					
	Injection	Direct					
2	Number of cylinders	6 in-line					
3	Bore	104 mm (4.1 inches)					
4	Stroke	132 mm (5.2 inches)					
5	Total displacement	6728cm³ (410.6 cubic inches)					
6	Compression ratio						
7	Maximum power rating (net power at flywheel ISO 14396)	137 kW @ 2100 rpm	148 kW @ 2100 rpm	157 kW @ 2000 rpm	145 kW @ 2000 rpm	169 kW @ 2000 rpm	197 kW @ 2200 rpm
		184 hp @ 2100 rpm	198 hp @ 2100 rpm	211 hp @ 2000 rpm	194 hp @ 2000 rpm	227 hp @ 2000 rpm	130 hp @ 2200 rpm
8	Maximum Torque	710 Nm @ 1400 rpm	810 Nm @ 1400 rpm	952 Nm @ 1400 rpm	860 NM @ 1400 rpm	1002 Nm @ 1400 rpm	607 Nm @ 1400 rpm
		524 pound feet @ 1400 rpm	597 pound feet 1400 rpm	702 pound feet @ 1400 rpm	634 pound feet @ 1400 rpm	739 pound feet @ 1400 rpm	607 pound feet @ 1400 rpm
9	No-load idle	700 rpm					
10	No-load peak rpm						
11	Boosting (type of turbocharger)	With intercooler HOLSET HX35					



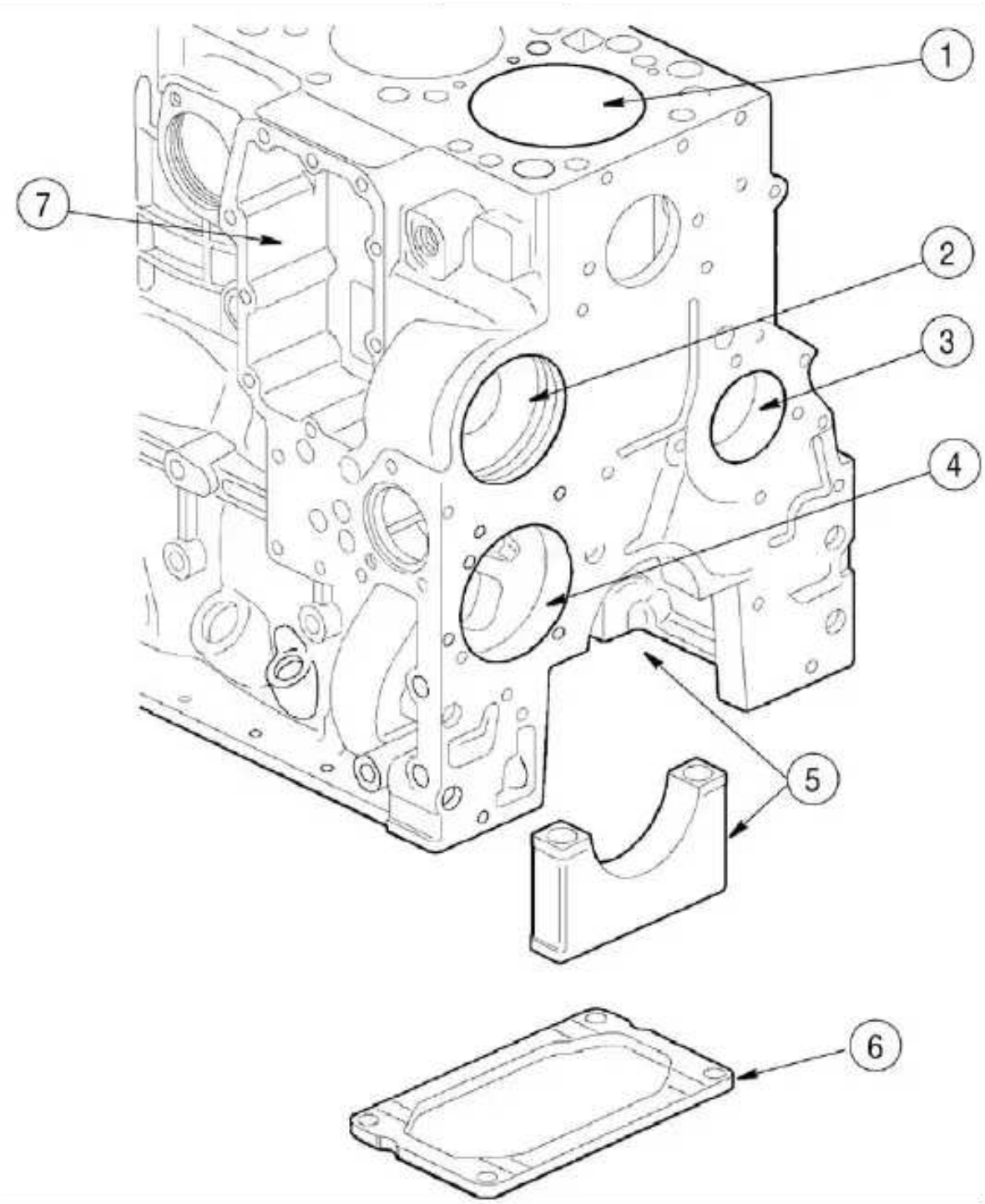
REF. NO.	ENGINE TYPE	667TA					
		EEG	EEC	EBF	EED	EBD	EDJ
12	Lubrication.	Forced by means of gear pump. Oil psi control valve.					
	Oil pressure with hot engine: at idle rpm.	1.2 bar (17.4 psi)					
	Oil pressure with hot engine: at peak rpm.	3.8 bar (55.1 psi)					
13	Cooling.	Fluid					
	Water pump drive.	Belt					
	Thermostat start of opening temperature.	79 to 83° C (174 to 181° F)					83 to98° C (181 to 208° F)
14	Oil capacity 1st filling.	No Information Available		No Information Available			
	Oil capacity engine sump.	No Information Available		No Information Available			
	Oil capacity engine sump + filter.	17 litres (18 qt.)		19 litres (20 qt.)			
15	Feeding Bosch-type injection	High pressure Common Rail					
16	Pump setting	No Information Available					
17	Start of delivery	No Information Available					
18	Type of injector	CRIN 1		CRIN 2			CRIN 2
19	Injection sequence	1 -5 -3 -6 -2 -4					
20	Injection pressure	--		250 - 1600 bar	250 -1400 bar	250 - 1600 bar	--
		--		3626 - 23206 psi	3626 - 20305 psi	3626 - 23206 psi	--

Description of the Main Mechanical Components of the Engine

Crankcase

1. Block made of cast iron which contains the cylinder bores
2. Water Pump
3. Camshaft Bushings and tappets
4. Oil Pump
5. Main Bearing Housings
6. Stiffening Soleplate which is installed to the underside of the block to increase resistance to mechanical Stress.
7. Water/oil heat exchanger

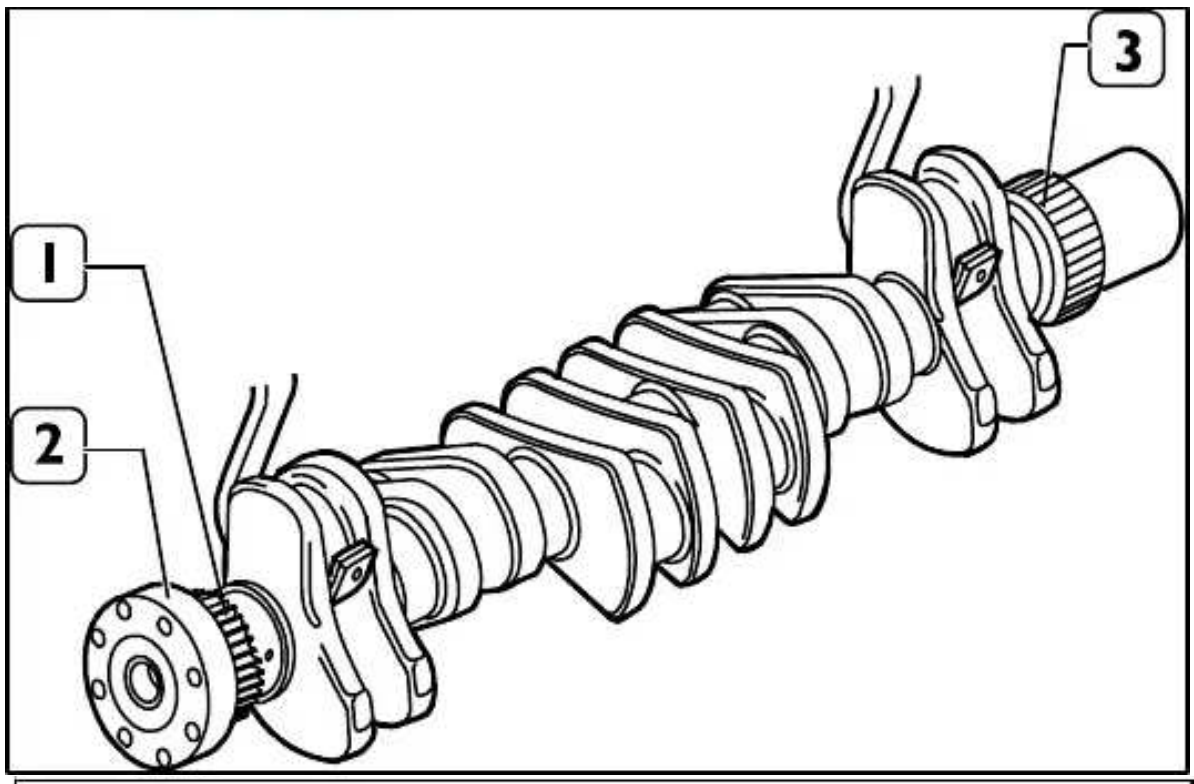
The block also contains chambers for circulation of coolant and oil galleries for the lubrication circuit feeding the various moving parts.



Crankshaft

The crankshaft is made of steel. The crankshaft is held on seven bearing journals for the six cylinder version of the F4 Engine. The journals are induction hardened.
The crankshaft features a series of internal drillings for lubrication purposes.
The front of the crankshaft is fitted with an oil pump drive gear, a speed sensor wheel, a vibration damper, and the auxiliary equipment driving pulley. The oil pump drive gear can be serviced.
The rear of the crankshaft is fitted with the timing gear and the engine flywheel attachment hub.

The main bearing shells are made of steel with antifriction alloy plating.
One of the main bearing shells are equipped with shoulders to limit crankshaft end float.
The timing gear and flywheel hub, Parts (1, 2) are mounted on the rear of the crankshaft with an interference fit and cannot be replaced.



1. Timing gear
2. Flywheel hub
3. Oil pump drive gear.

Note: Timing gear is timed to crankshaft. Damage to gear requires crank replacement

Crankshaft oil seals

The front and rear oil seals are cassette type, with a radial seal. These oil seal rings require special tools for disassembly and assembly as described later in this manual.

Connecting rods

Forged in steel, the connecting rod big ends are made with an oblique angle, with separation of rod and cap achieved by means of the innovative fracture splitting system rather than the conventional machining procedure.

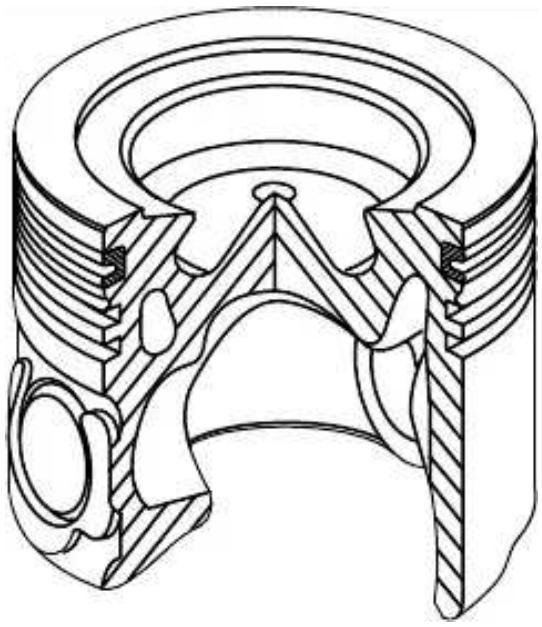
The connecting rod big end bearing shells are made of steel plated with an antifriction alloy.

Each connecting rod is marked:

- On the body and on the cap by a number indicating the match and the cylinder in which they are assembled.
- The rod shank is marked with a letter indicating the weight class of the connecting rod installed in production. Three weight classes are used.

In the event of replacement, the spare parts catalog only provides a single connecting rod of intermediate weight compatible with all engines in circulation. In the event of single rod replacements, connecting rods that are still in good condition need not be replaced, even though they may be of a different weight class.

Pistons



The piston crown for the E series has been changed to increase combustion efficiency in order to reach Tier 3 emissions (The above picture is not actual E series piston). It features a high turbulence combustion chamber. The underside of the piston crown is cooled by engine oil delivered by a spray nozzle installed in the crankcase.

There are three piston ring grooves; the first is composed of a trapezoidal section (keystone shaped) cast iron insert.

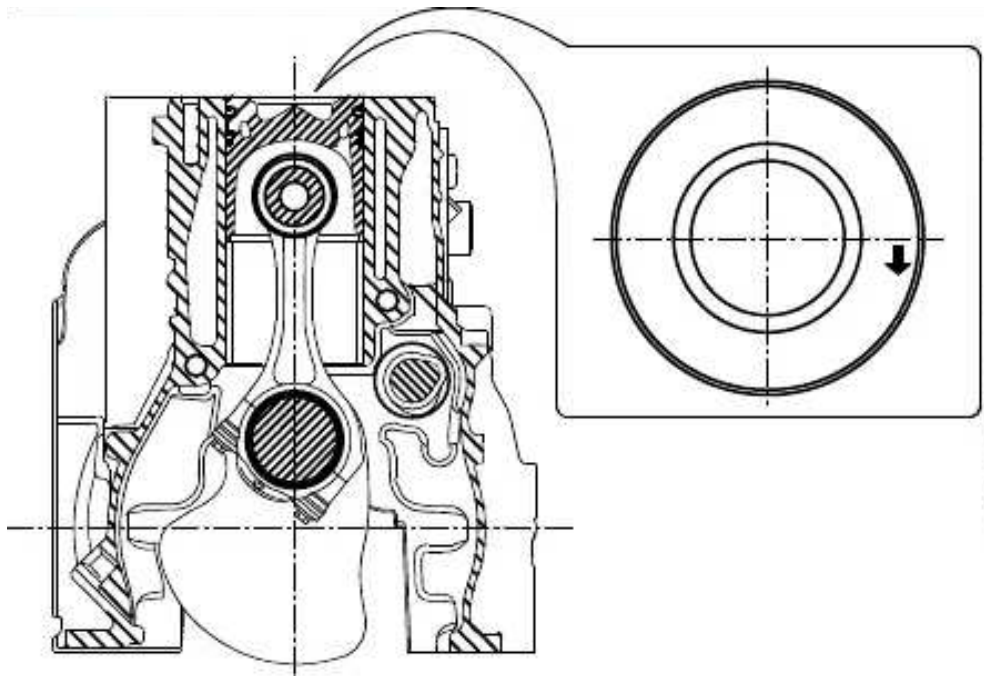
The piston rings have different functions and different geometry.

1st piston ring with trapezoidal section and ceramic chrome plating.

2nd piston ring with torsional conical rectangular section.

3rd piston ring with double oil wiper with internal spring.

The piston crown is marked with an arrow showing the direction of assembly inside the cylinder bore. The piston must be installed with the arrow facing towards the front of the crankcase.

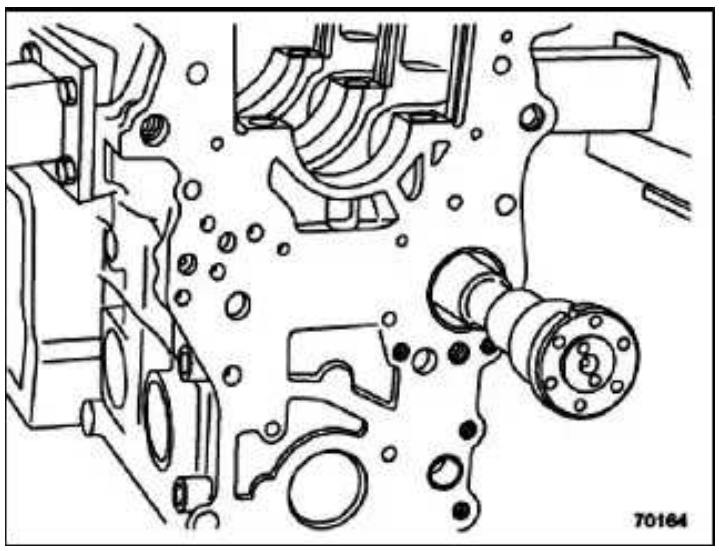


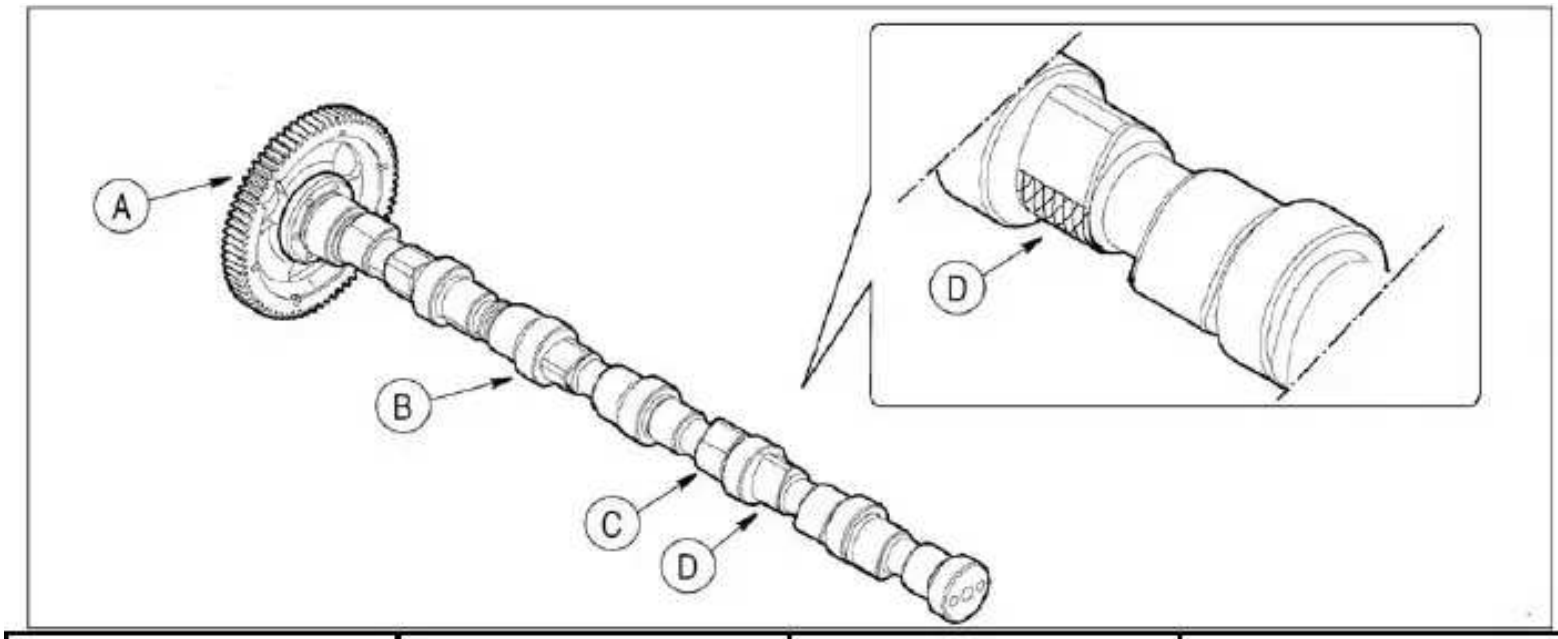
NEF TIER 3 ELECTRONIC ENGINE

Camshaft

The camshaft is mounted in the crankcase on 5 journals (4 cylinder engine) or 7 journals (6 cylinder engine). The front and rear bearing housings are equipped with steel bushings plated with antifriction material assembled by means of an interference fit. The camshaft has two cam lobes for each cylinder which are the following:
C. Intake valves control
D. Exhaust valves control

The camshaft is driven directly by the crankshaft by means of the rear spur tooth gears. The engine side of the timing gear is marked with notches, equal to the number of cylinders, for activation of the camshaft timing sensor plus one notch to indicate the Top Dead Center position (6 + 1).





A. Crank Shaft Output Gear	B. Journal	C. Intake Valve Lobe	D. Exhaust Valve Lobe
Note the camshaft is for a 6 cylinder engine.			

EGR Exhaust Gas Recirculation System

The exhaust gases can be partially conveyed back into the cylinders to lower the maximum values of the combustion temperature that are responsible for the production of nitrogen oxides (NOx). The exhaust gas recirculation system (EGR) lowers the combustion temperature by decreasing the concentration of oxygen in the combustion chamber. Therefore, it is an effective system to control the emission of NOx.

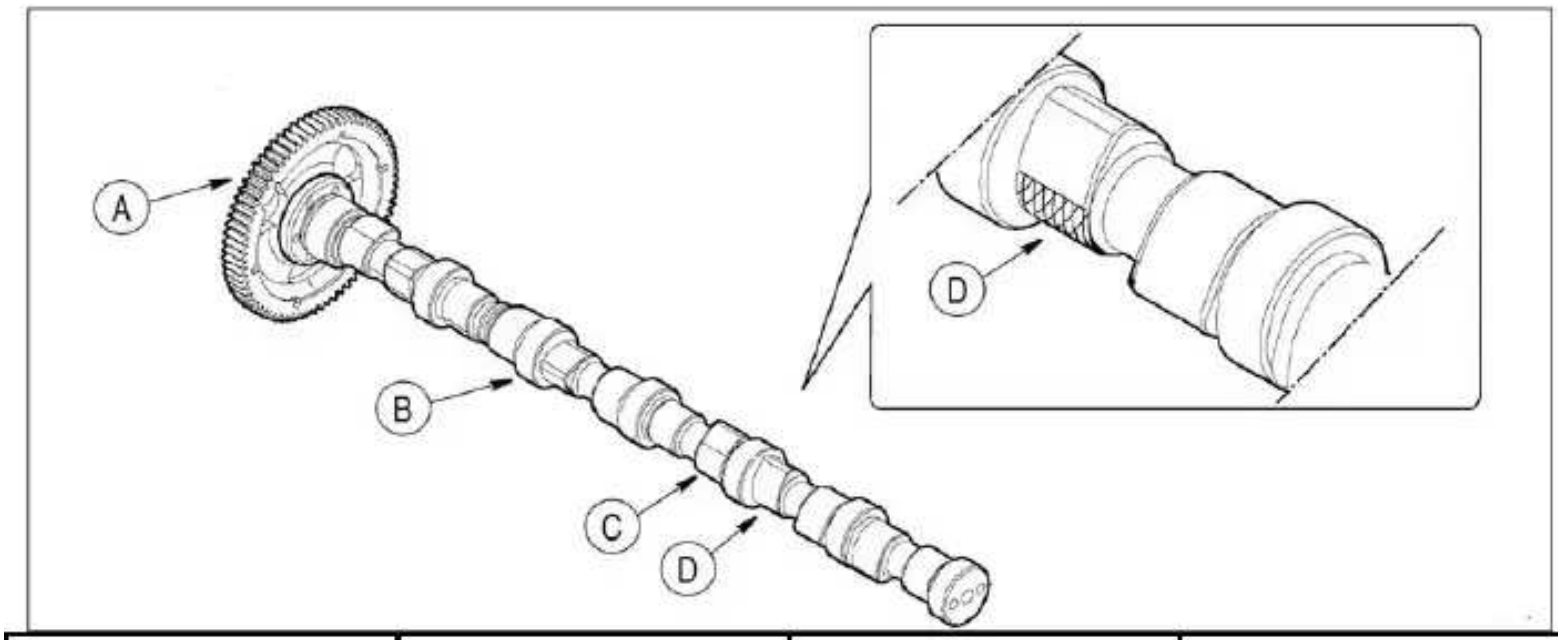
In the TIER 3 version, the profile of the exhaust lobe has been modified in order to allow the partial opening of the exhaust valve during the intake cycle. The exhaust gases can be partially returned back into the cylinders to lower the maximum combustion temperature which is responsible for the production of nitrogen oxides (NOx).

The exhaust gas recirculation system (EGR) lowers the combustion temperature by decreasing the concentration of oxygen in the combustion chamber. This creates an effective system to control the emission of NOx.

The internal EGR system exhaust lobe design is not equipped with any electronically controlled elements which makes the system always active. Its configuration does not need additional elements such as check valves, piping or heat exchangers.

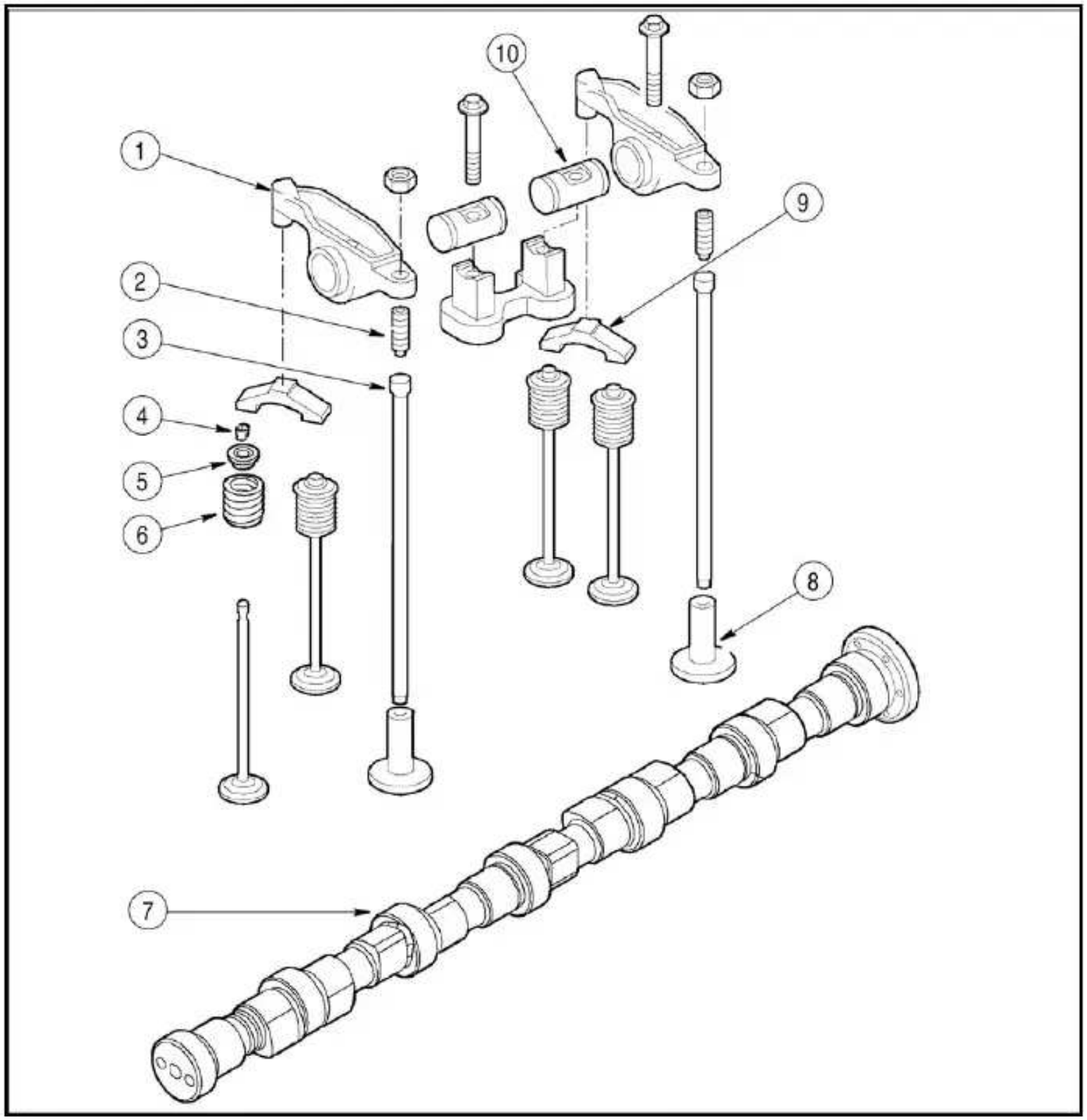
The exhaust lobe (D) has an additional lobe apart from the major lobe see cross sectional view of exhaust valve (D), as compared to the configuration of a cam without EGR.

With the additional lobe during the intake stroke of a cylinder, this lobe permits a brief opening of the exhaust valve. Recirculation is generated in the cylinder during the intake stroke due to the greater pressure of exhaust compared to the intake gases.



A. Crank Shaft Output Gear	B. Journal	C. Intake Valve Lobe	D. Exhaust Valve Lobe
Note the camshaft is for a 6 cylinder engine.			

Valve Train



1. Rocker Arm	6. Spring
2. Adjustment Screw	7. Camshaft
3. PUSH ROD	8. Tappet
4. Valve Spring Retainer (Keepers)	9. Valve Bridge Note. The valve bridge is directional. The slotted side goes towards exhaust
5. Spring Seat	10. Rocker Spindle

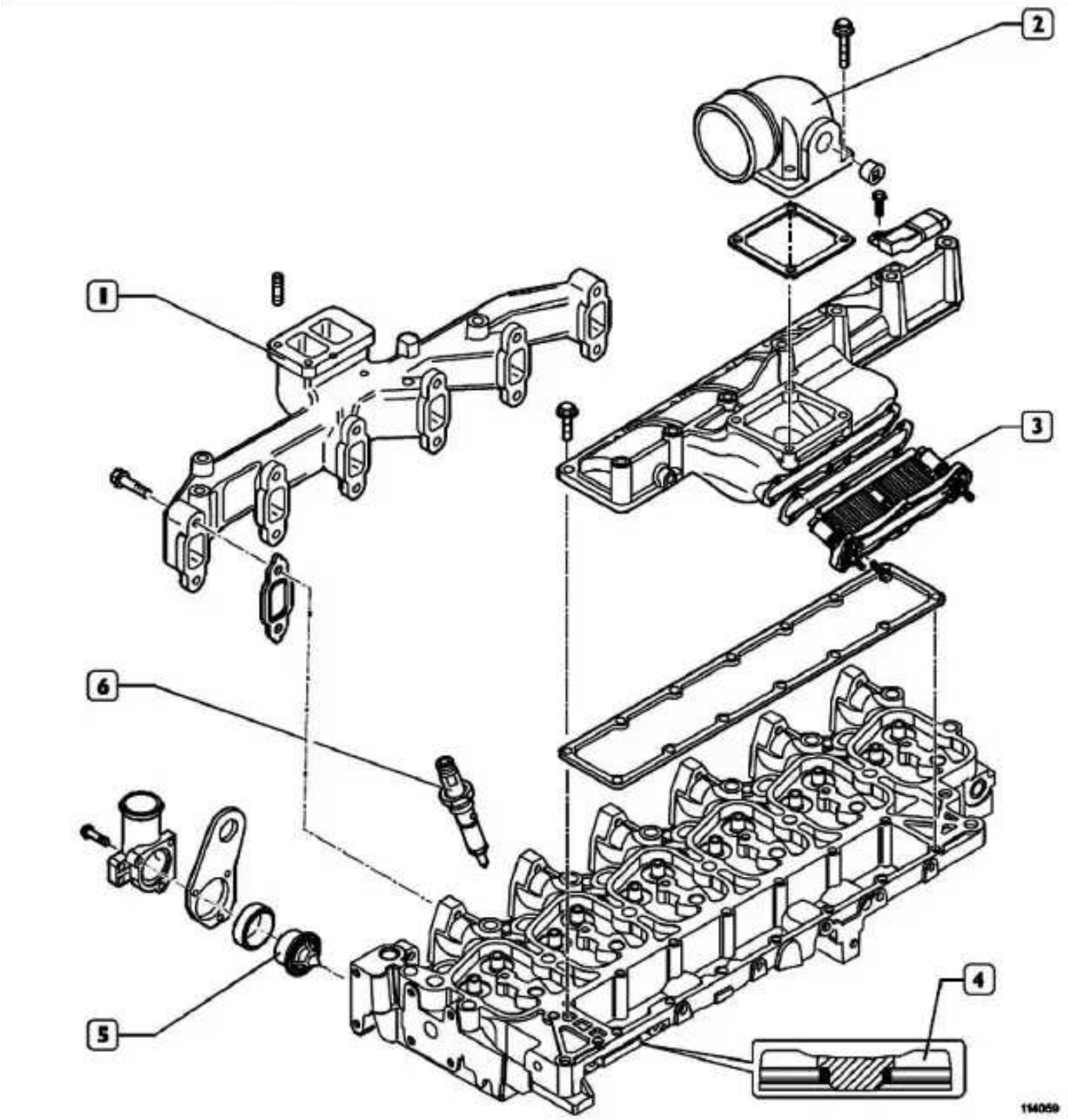
Cylinder head

The seats of the following parts are obtained on the cast--iron cylinder head:

- Inserted valve seats (4)
- Injectors (6)
- Thermostat (5)

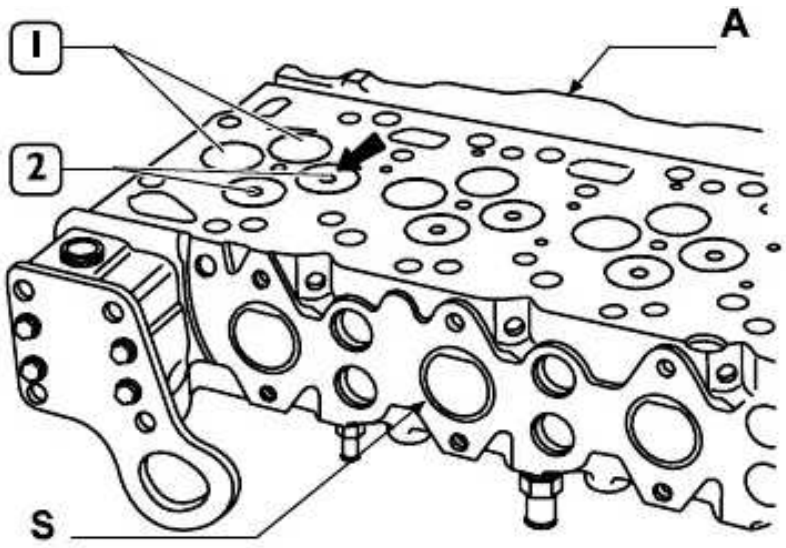
Moreover, the following components are inserted on the heads:

- Single--block exhaust manifold (1);
- Intake manifold (2) with seat for cold start air heater (3).



DETAIL OF CYLINDER HEAD WITH INSERTED VALVE SEATS

Valves and valve seats

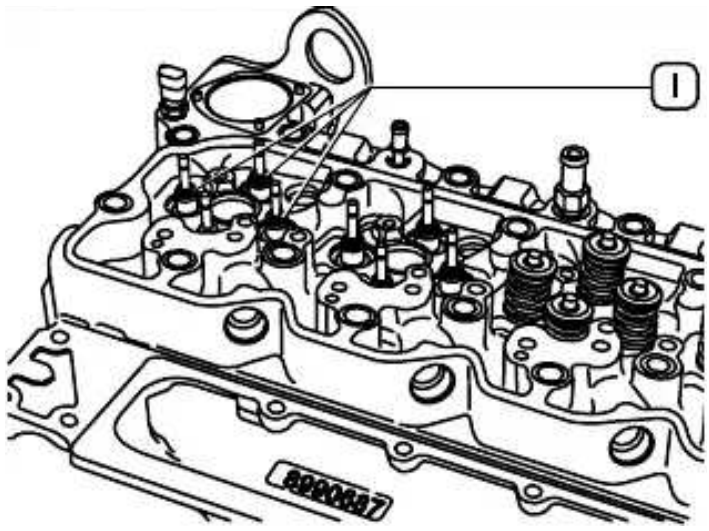


1. Intake valve	A. Intake side
2. Exhaust valve	S. Exhaust side.

The valve seats have the following angles:

- 45° for the exhaust valves
- 60° for the intake valves

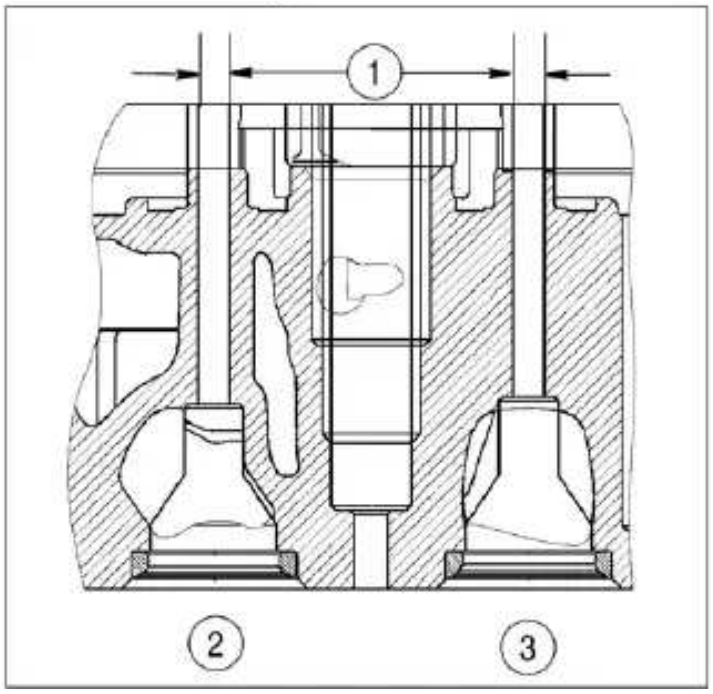
The exhaust valves (2) have an identification recess at the center of the valve head.



This figure shows the oil seals mounted on the valve stems.

Valve guides

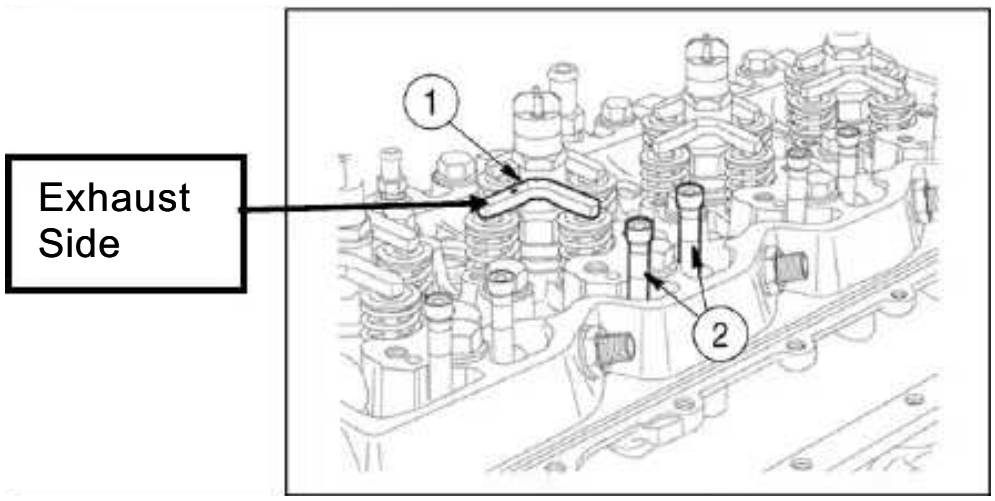
The cylinder head does not have valve guide inserts. The valve guide is machined directly into the head casting.



1. 7.042 to 7.062MM (0.277 TO 0.278 IN)
2. Intake Valves
3. Exhaust Valves

Valve control bridges

When installing the cylinder head check the orientation of the valve control bridges. The bridges must be located so that the notches (→) are facing the exhaust manifold.
NOTE: When remounting the cylinder head, the orientation of valve bridges must be observed.
Jumpers must be positioned with marks (→) towards exhaust manifold.

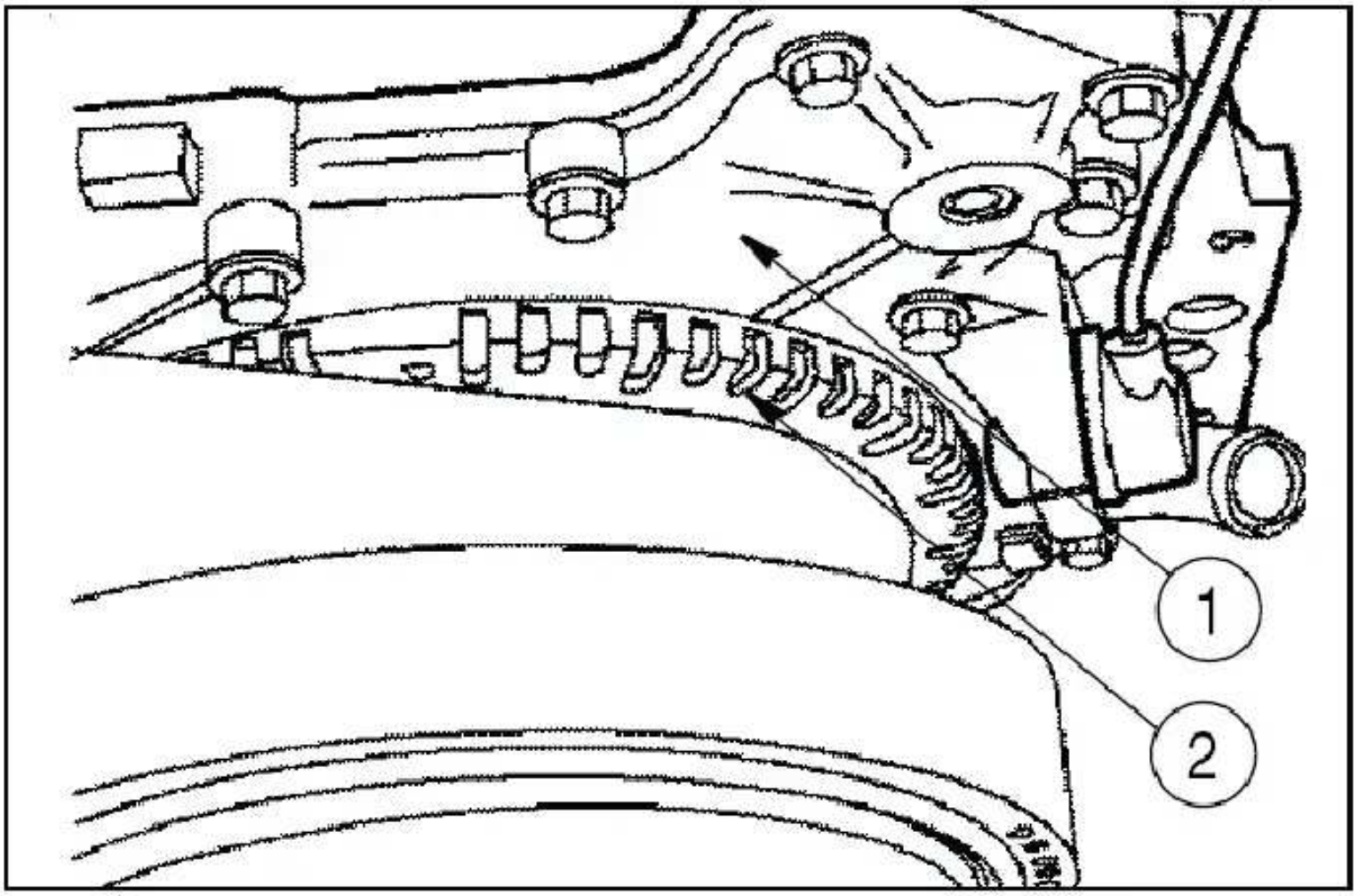


1. Valve Bridge	2. Push Rods

NEF TIER 3 ELECTRONIC ENGINE

Locating Top Dead Center for 4 Cylinder Engines

IMPORTANT: Due to the additional lobe for the Internal EGR, each cylinder must cylinder must be adjusted by taking it to the TDC. (top dead center) and adjusting the clearance of both valves on every cylinder.



1. ENGINE BLOCK	2. TONE WHEEL

1. Remove the injector from the number one cylinder.
2. Rotate engine over using Special Tool 380000988 to bring the number one cylinder to the highest point using a dial indicator. Check to see if push rods are loose, if they are not rotate the engine 360° now they should be loose.
3. Put a reference mark on tone wheel (1) and the engine block (2) this is TDC of Cylinder 1.
4. Measure the circumference of the tone wheel and divide by 2. Starting from the reference mark on tone wheel; put the other mark of the calculated length on the tone wheel.

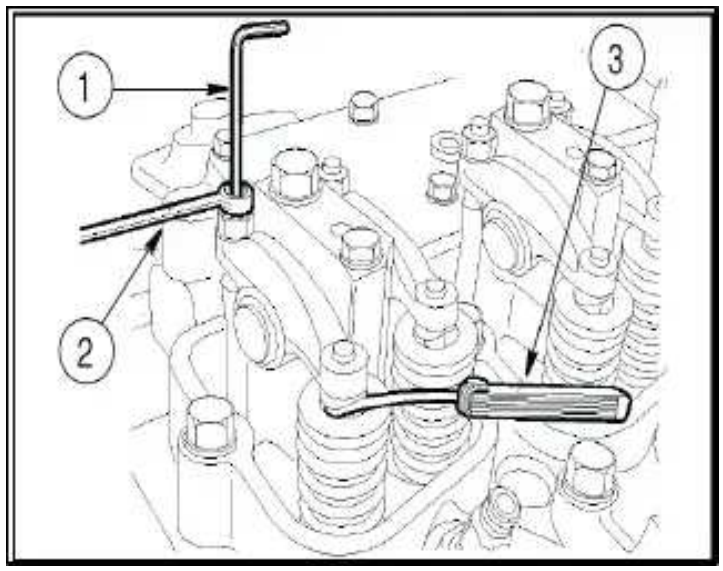
Adjusting Valve Play for a 4 Cylinder Engine

Note: The firing order for a 4 cylinder engine is (1, 3, 4, 2).

Note: before making any adjustment on the valve clearance, on the desired cylinder, check to see that both valves are loose. If they are not, you are on the wrong cylinder.

Note: On tier 3 engines, due to the additional lobe for the Internal EGR (Exhaust Gas Recirculation), it is not possible to use the valve clearance procedure that requires adjusting the valve clearance of all the valves by positioning the crankshaft 2 times only. Each cylinder must be checked by taking it to Top Dead Center (TDC) at the end of the compression stroke and adjusting the clearance of both valves on the cylinder.

1. Verify that cylinder 1 is at TDC at the end of the compression stroke and adjust the valves for (Cylinder 1).
2. Rotate engine to the next mark and adjust valves for (Cylinder 3).
3. Rotate engine to the next mark and adjust the valves for (Cylinder 4).
4. Rotate engine to the next mark and adjust the valve s for (Cylinder 2).
5. Install Injector number 1.



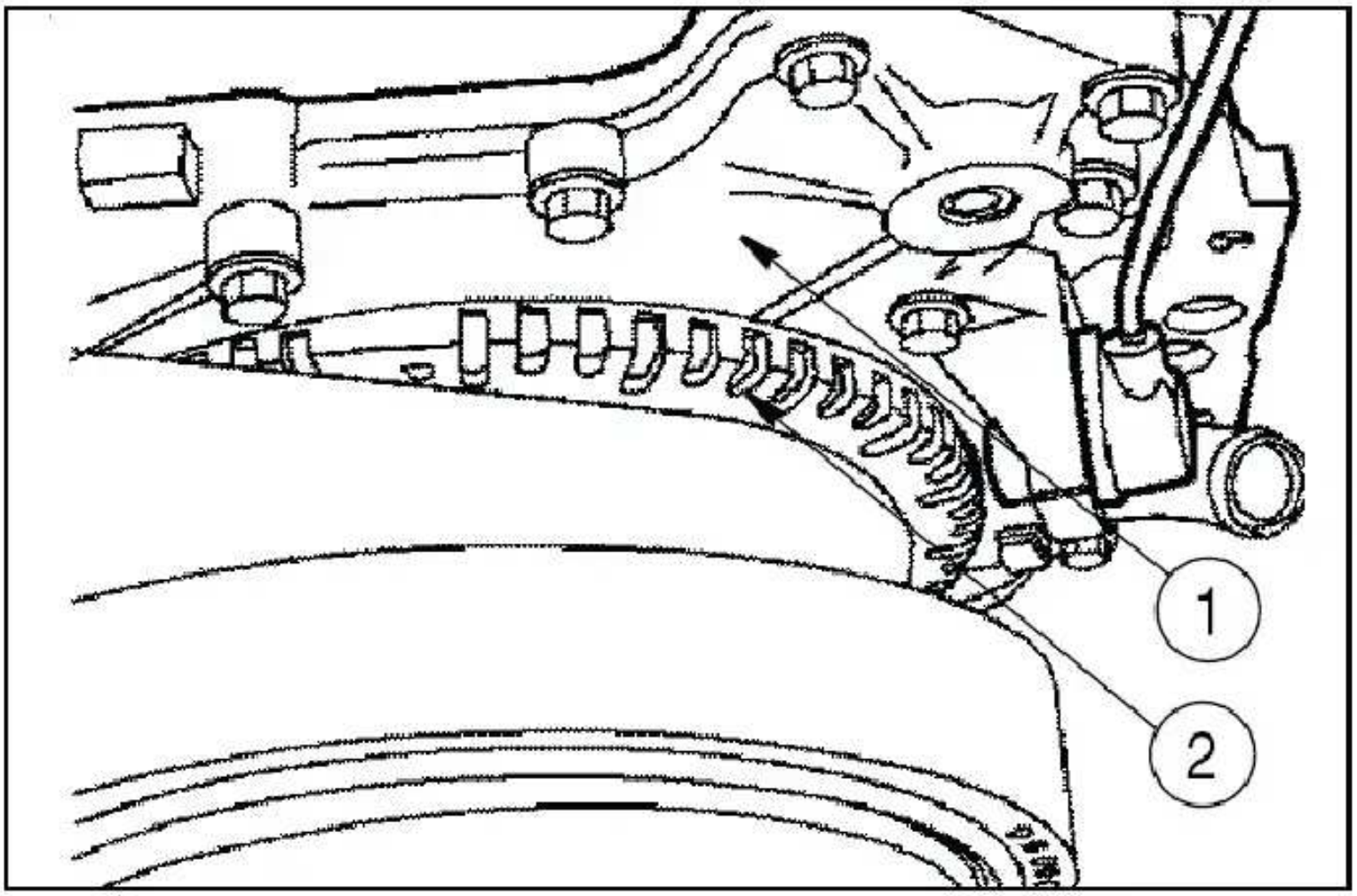
Adjust the clearance between rockers and valves using set screw wrench (1), box Wrench (3), and feeler Gage (2).

Working clearance shall be as follows:

- Intake Valves: 0.20 – 0.30 mm (0.008 – 0.012 in)
- Exhaust Valves: 0.46 – 0.56 mm (0.18 – 0.222 in)

Locating Top Dead Center for 6 Cylinder Engines

IMPORTANT: Due to the additional lobe for the Internal EGR, each cylinder must cylinder must be adjusted by taking it to the TDC. (top dead center) and adjusting the clearance of both valves on every cylinder.



1. ENGINE BLOCK	2. TONE WHEEL

1. Remove the injector from the number one cylinder.
2. Rotate engine over using Special Tool 380000988 to bring the number one cylinder to the highest point using a dial indicator. Check to see if push rods are loose, if they are not rotate the engine 360° now they should be loose.
3. Put a reference mark on tone wheel (1) and the engine block (2) this is TDC of Cylinder 1.
4. Measure the circumference of the tone wheel and divide by 3. Starting from the reference mark on tone wheel; put the other two marks of the calculated length on the tone wheel.

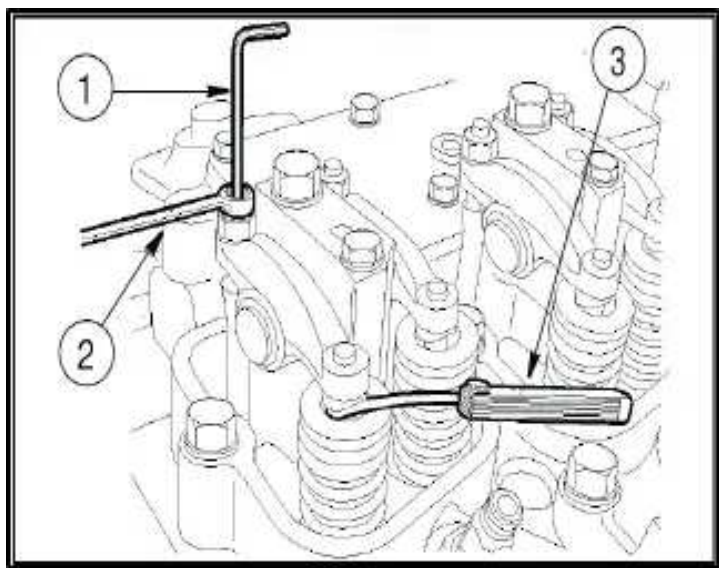
Adjusting Valve Play for a 6 Cylinder Engine

Note: The firing order for a 6 cylinder engine is (1, 5, 3, 6, 2, 4).

Note: before making any adjustment on the valve clearance, on the desired cylinder, check to see that both valves are loose. If they are not, you are on the wrong cylinder.

Note: On tier 3 engines, due to the additional lobe for the Internal EGR (Exhaust Gas Recirculation), it is not possible to use the valve clearance procedure that requires adjusting the valve clearance of all the valves by positioning the crankshaft 2 times only. Each cylinder must be checked by taking it to Top Dead Center (TDC) at the end of the compression stroke and adjusting the clearance of both valves on the cylinder.

1. Verify that cylinder 1 is at TDC at the end of the compression stroke and adjust the valves for (Cylinder 1).
2. Rotate engine to the next mark and adjust valves for (Cylinder 5).
3. Rotate engine to the next mark and adjust the valves for (Cylinder 3).
4. Rotate engine to the next mark and adjust the valve s for (Cylinder 6).
5. Rotate engine to the next mark and adjust the valve s for (Cylinder 2).
6. Rotate engine to the next mark and adjust the valve s for (Cylinder 4).
7. Install Injector number 1.



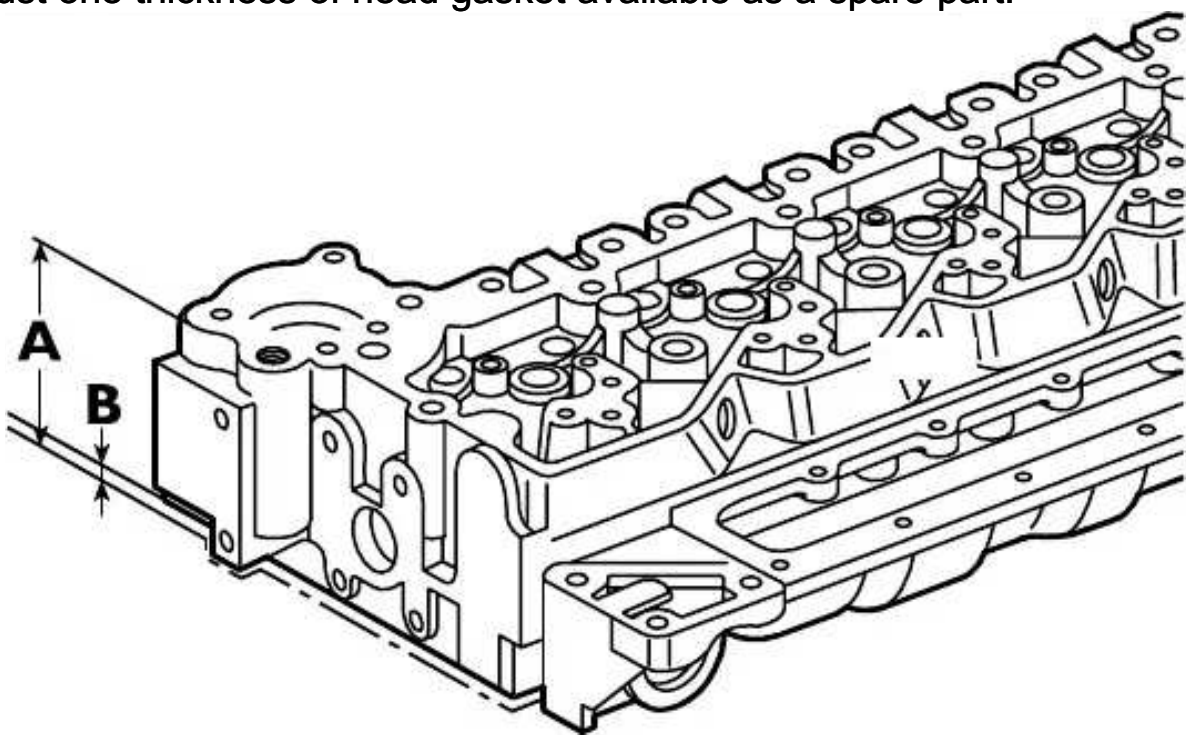
Adjust the clearance between rockers and valves using set screw wrench (1), box Wrench (3), and feeler Gage (2).

Working clearance shall be as follows:

- Intake Valves: 0.20 – 0.30 mm (0.008 – 0.012 in)
- Exhaust Valves: 0.46 – 0.56 mm (0.18 – 0.222 in)

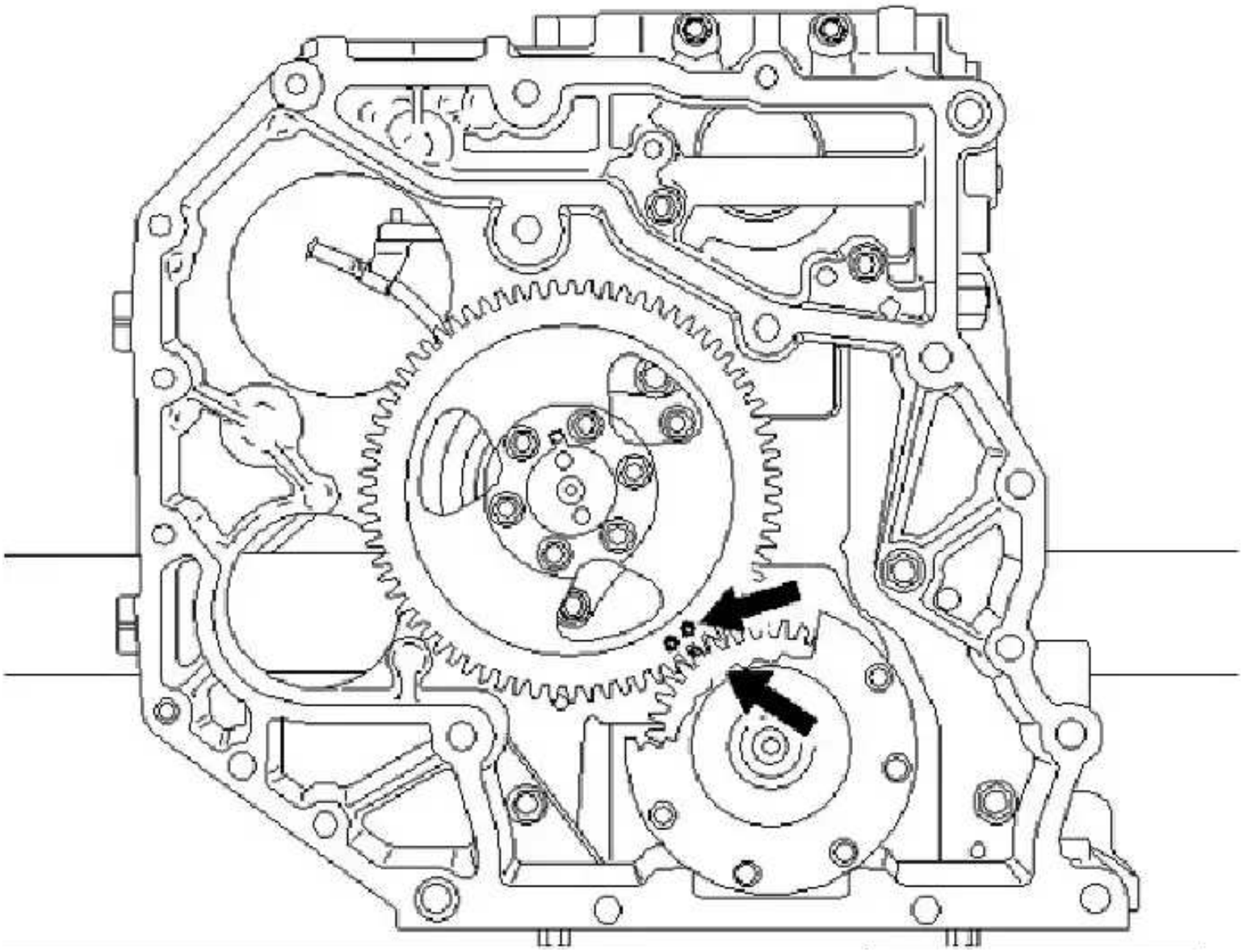
Head machining

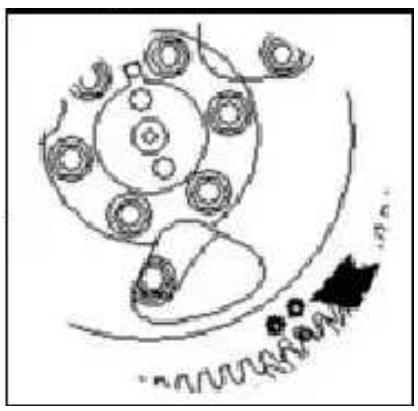
The nominal thickness of the cylinder head is 105 ± 0.25 mm and the maximum permissible removal of material must not exceed 0.13 mm.
There is just one thickness of head gasket available as a spare part.



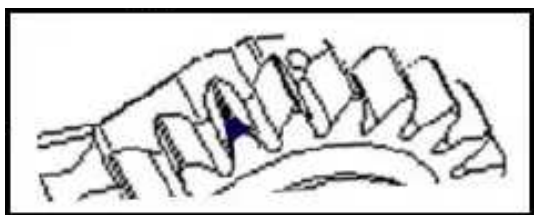
Timing gears

The timing drive is obtained by means of a spur tooth gear fitted on the rear of the crankshaft, which meshes with a corresponding spur tooth gear on the camshaft. Correct timing is achieved by aligning the (⇐) marks punched on the two gears.





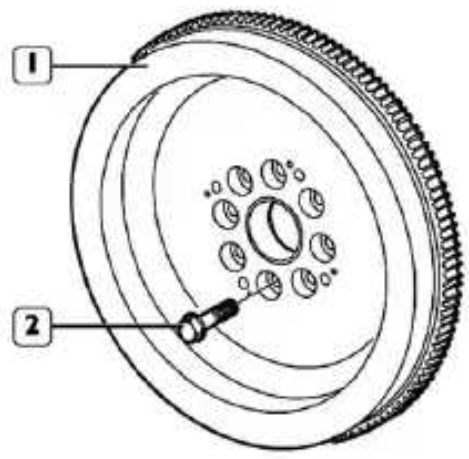
Crank gear has chamfered edge timing tooth



Engine flywheel

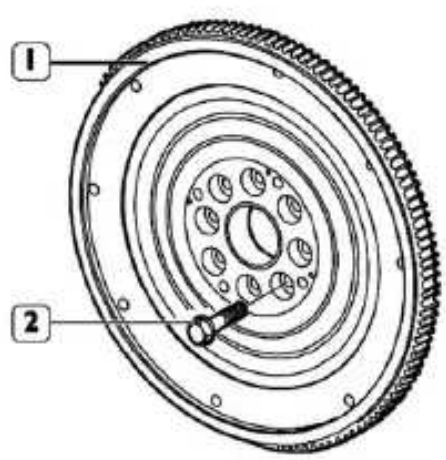
The flywheel (1) need not be installed in a specific position on the crankshaft, as it is not equipped with punch markings, notches, or reference holes for sensors or for timing purposes. The flywheel attaching holes (2) are equally spaced so that the flywheel can be installed in any different positions.

Figure 18



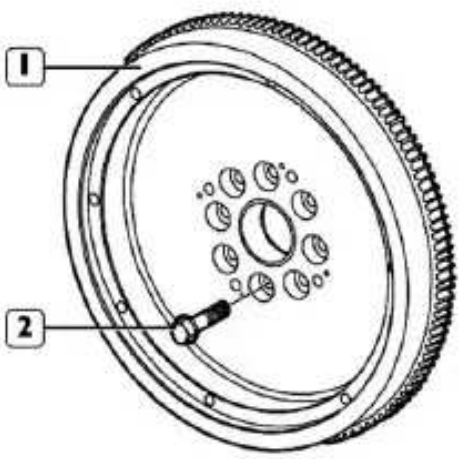
ENGINES: 667TA/EEG – 667TA/EEC

Figure 20



ENGINES: 667TA/EBF – 667TA/EED

Figure 19

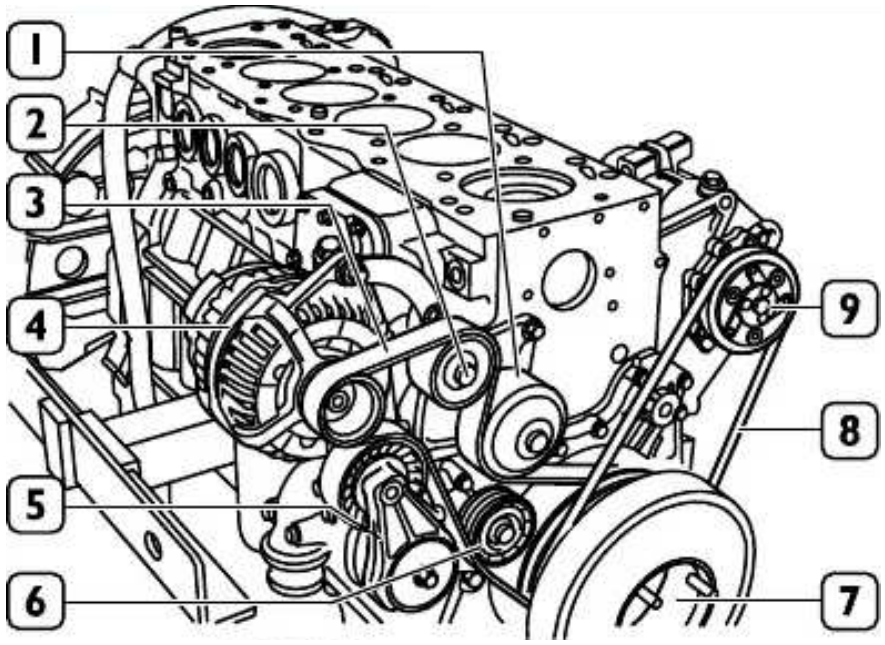


ENGINES: 667TA/EED – 667TA/EBD

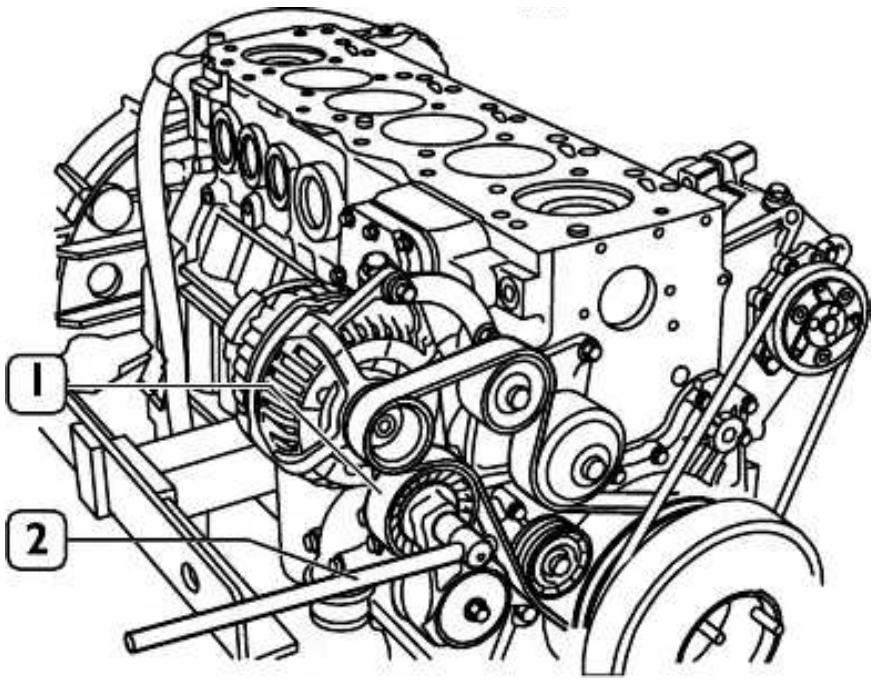
Accessory Equipment Drive

A Poly-V belt (3) transmits drive from the crankshaft (7) to the water pump (1) and the alternator (4).
The tension of this belt is automatically controlled by the calibrated spring housed in the automatic tensioner (5).
The fixed guide pulleys (2) and (6) ensure an appropriate contact surface area of the belt (3) on the pulleys of the alternator and water pump.

A "V" belt (8) transmits power from the crankshaft (7) to the air conditioner compressor (9).



Poly-V belt removal

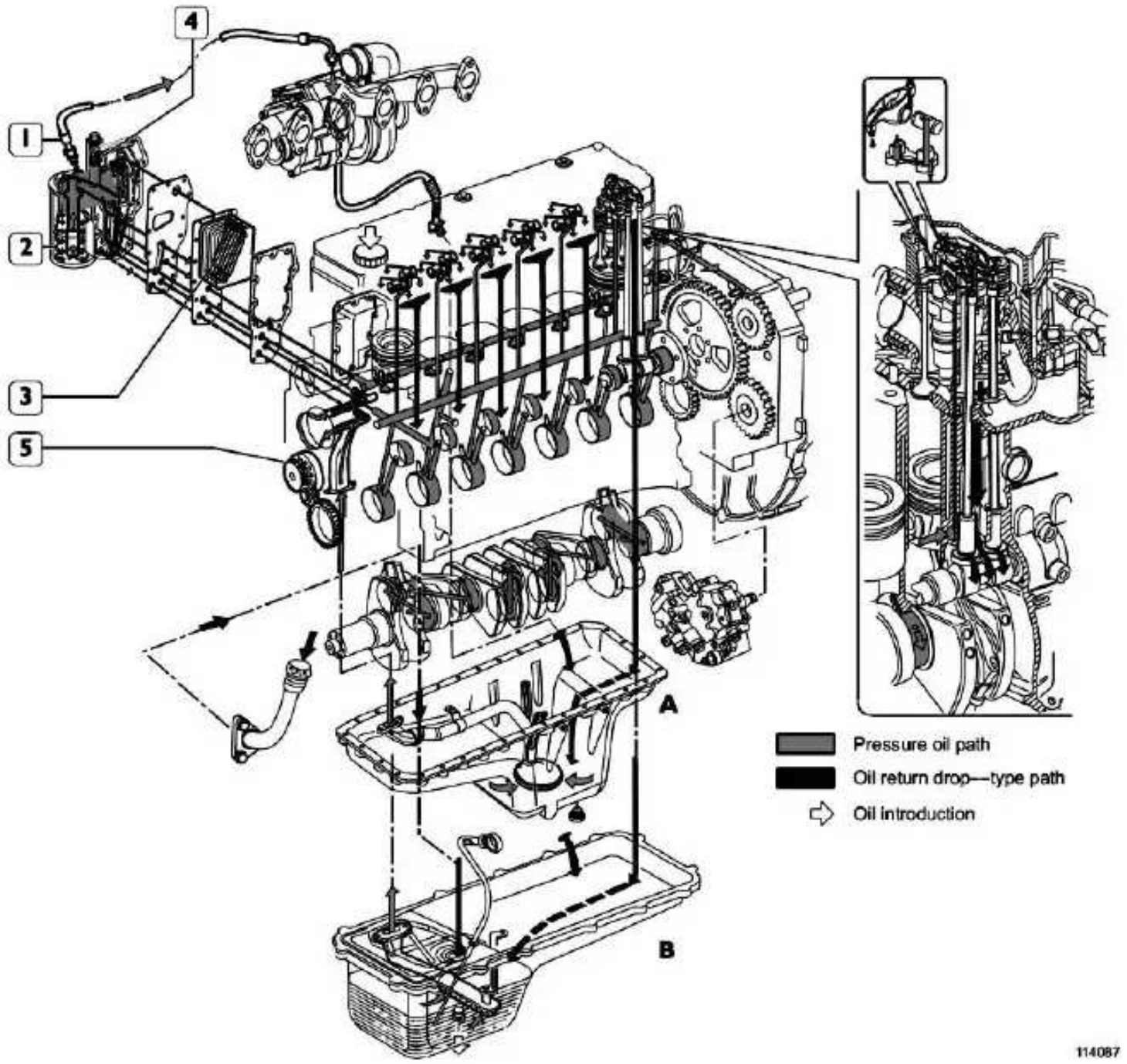


Remove or install the Poly - V belt by loosening tensioner (1) using a suitable wrench (2).

Lubrication

The pressurised engine lubrication system is made up of the following components:

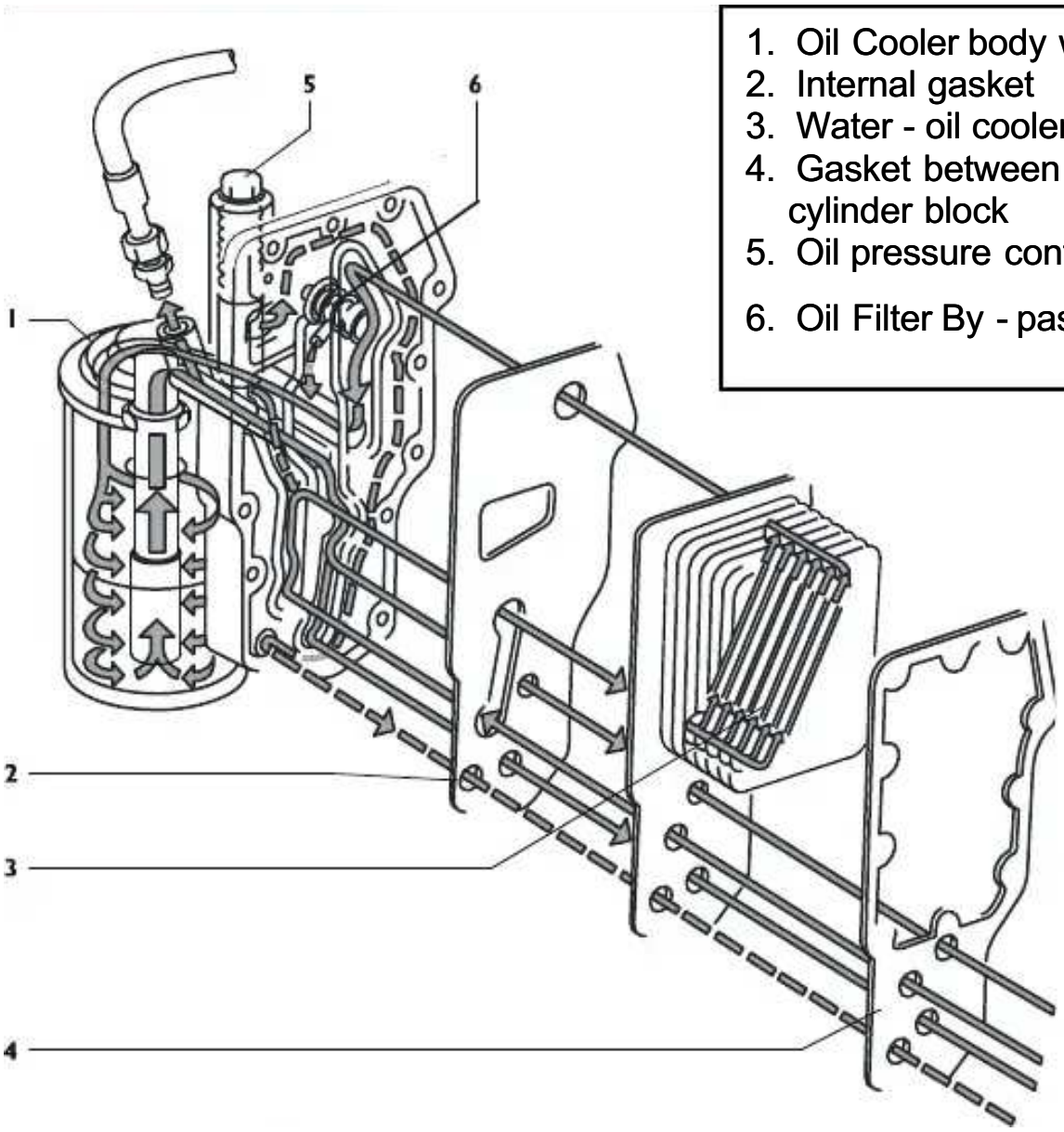
- Gerotor oil pump (5), housed in the front of the crankcase and driven by a spur tooth gear fitted on the front of the crankshaft;
- Water / oil cooler (3), housed in the block, under the oil filter support;
- Oil pressure control valve (1) incorporated in the filter support;
- By–pass valve (4) to exclude a clogged oil filter, incorporated in the filter support;
- Cartridge type oil filter (2).



A. Engine oil sump: 667TA/EED – 667TA/EBD

B. Engine oil sump: 667TA/EEG – 667TA/EEC – 667TA/EBF – 667TA/EED

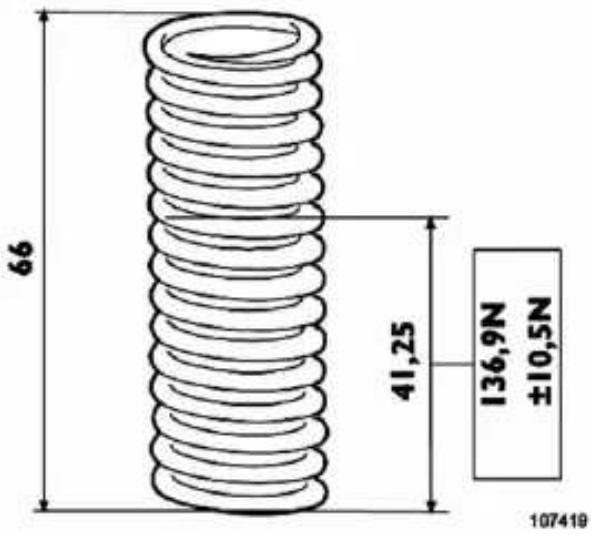
Engine Oil Cooler



1. Oil Cooler body with filter support
2. Internal gasket
3. Water - oil cooler
4. Gasket between oil cooler and cylinder block
5. Oil pressure control valve
6. Oil Filter By - pass valve

Oil pressure regulation valve

Figure 24



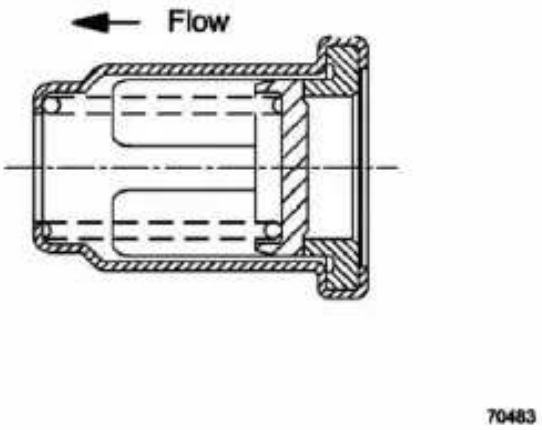
PRINCIPAL DATA FOR OIL PRESSURE REGULATION VALVE SPRING CHECKING

Pressure regulating calibration at 100_C oil temperature

- minimum speed 1.2 bar;
- maximum speed 3.8 bar.

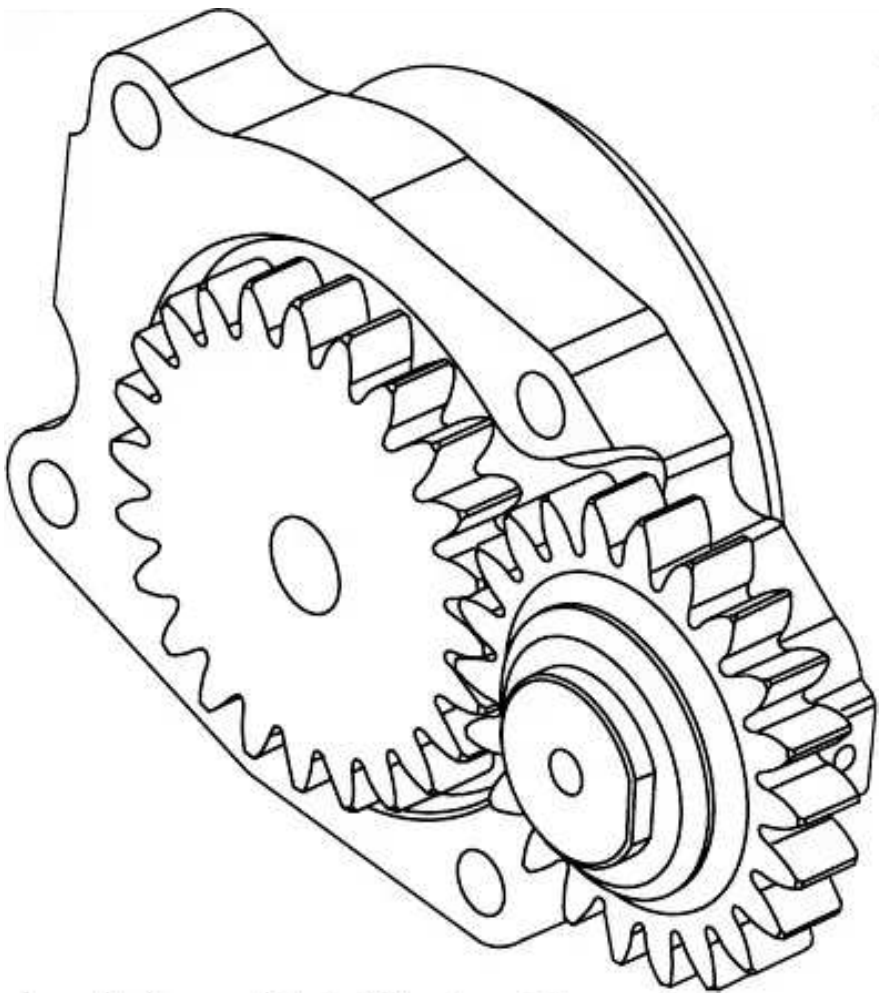
By-pass valve

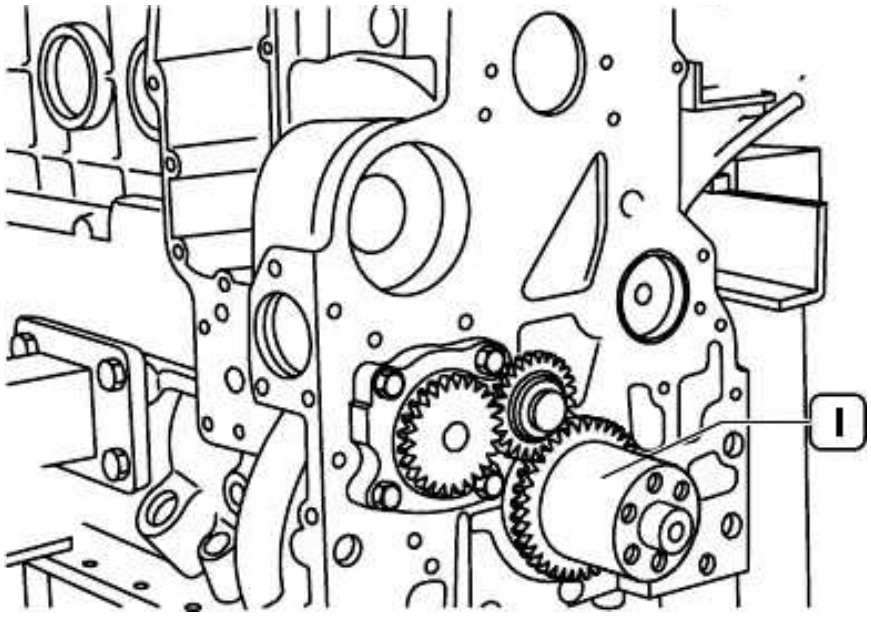
Figure 25



Blow-by max:
20 cm^3/l' with 0.83 bar pressure and 26.7 _C oil temperature.

Oil pump

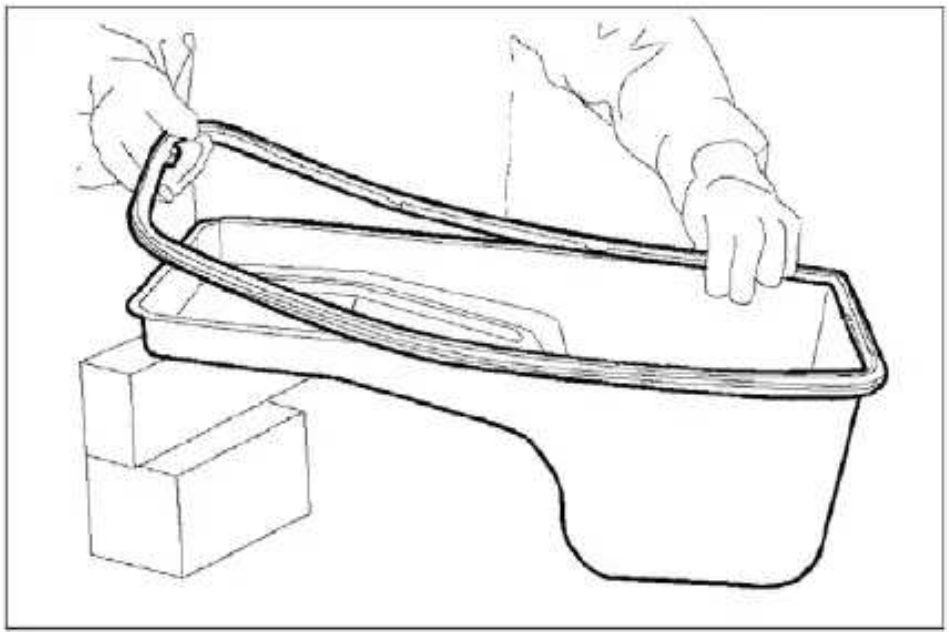


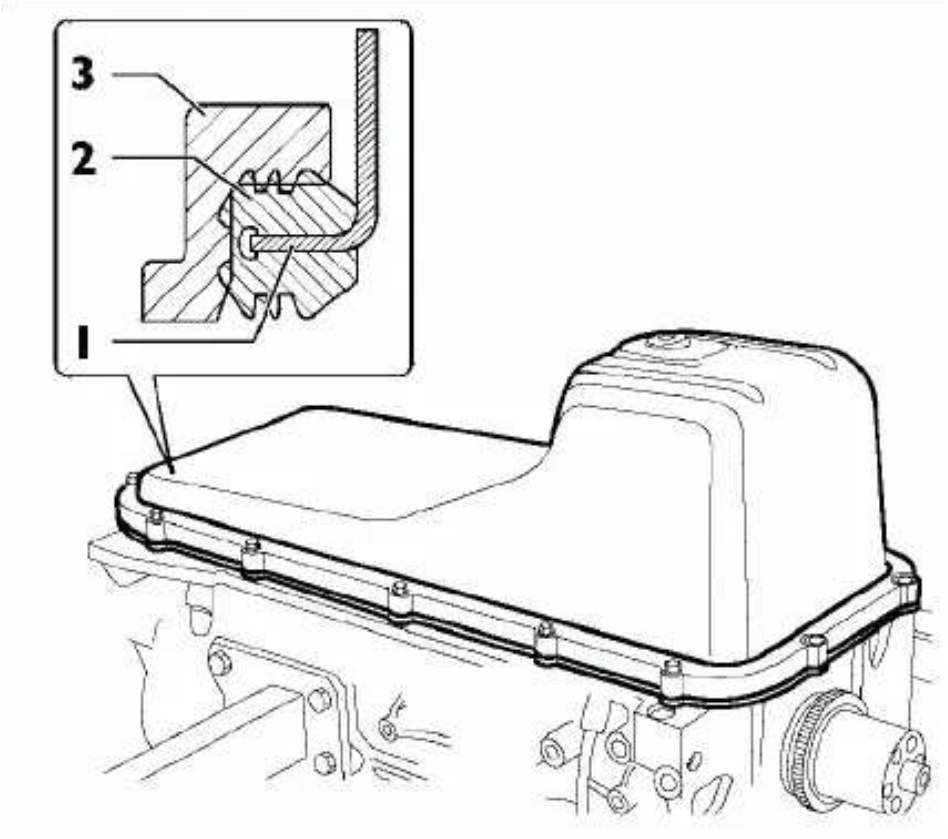


1. Crankshaft with oil pump drive gear

Sump (Suspended Oil Pan)

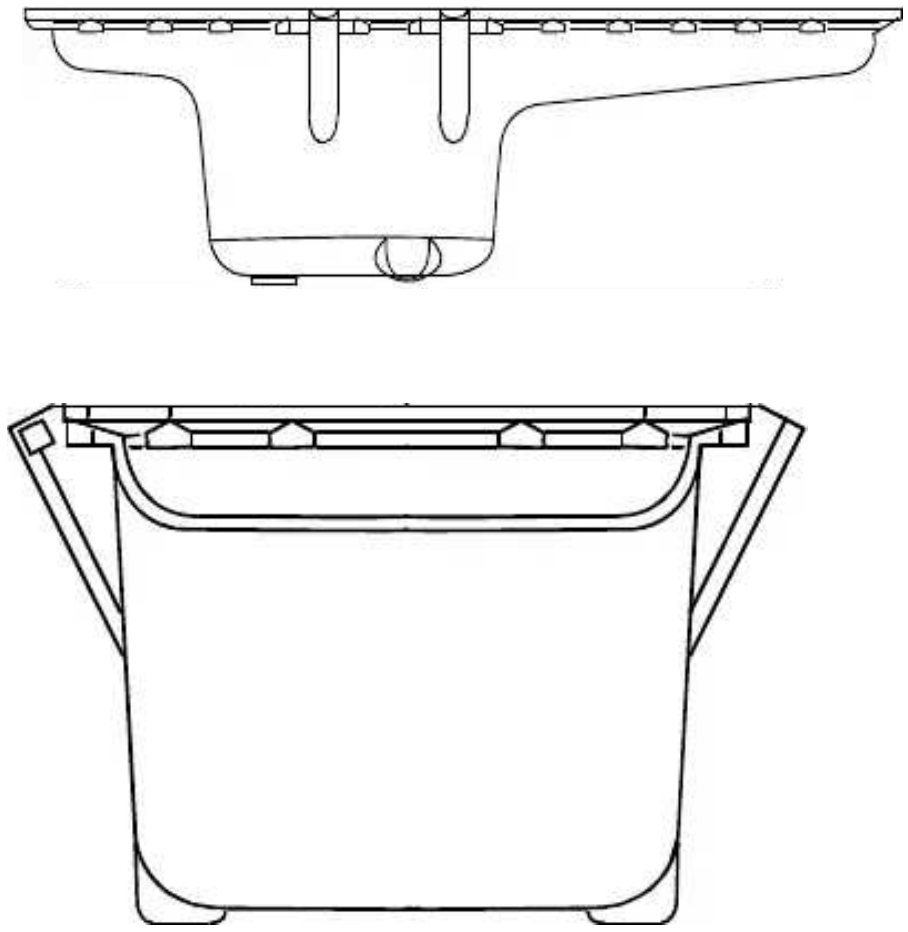
The steel oil pan (1) is secured to the crankcase by an aluminium plate (3) and a rubber gasket (2).
The “C” section rubber gasket (2), installed on the edge of the oil pan, serves to prevent leakage while also reducing the noise level.
This type of gasket should be replaced only in the event of deterioration or breakage.
It need not be replaced at each disassembly-reassembly.





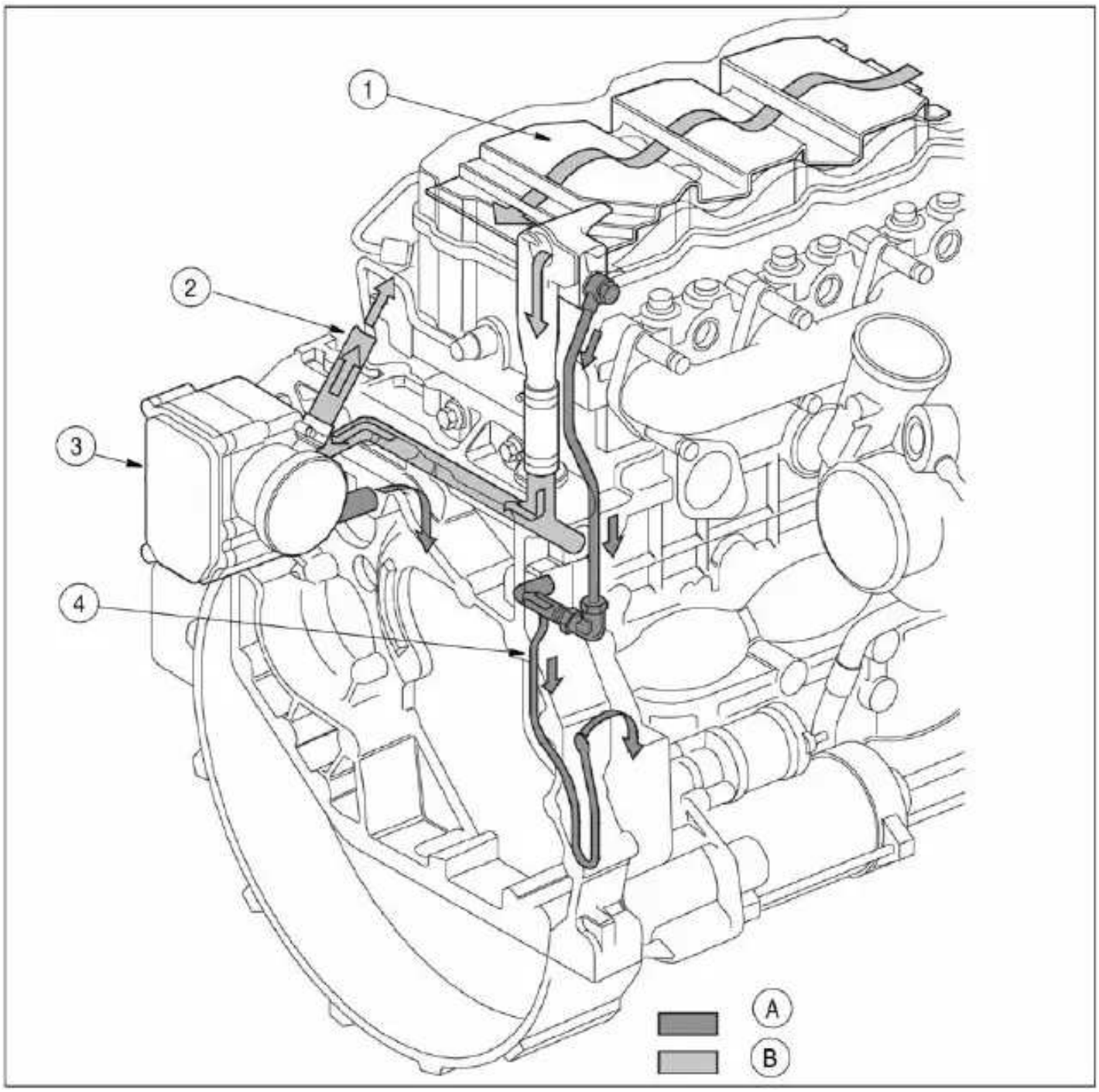
Conventional Sump (Oil Pan)

The cast iron sump is secured with bolts to the crankcase by means of a thin gasket.



Blow-By Recirculation

The rocker cover has a blow-by pre-separator (1), designed to increase the outlet velocity of blow-by oil vapor and also to cause the condensation of a portion of the entrained oil.
Condensed oil then returns to the sump while the residual vapors are collected and routed through blow-by filters (3).
In blow-by filter (3), a portion of the oil vapour condenses and returns to the sump, while the remainder is re-circulated to the engine intake side by way of pipeline (2).

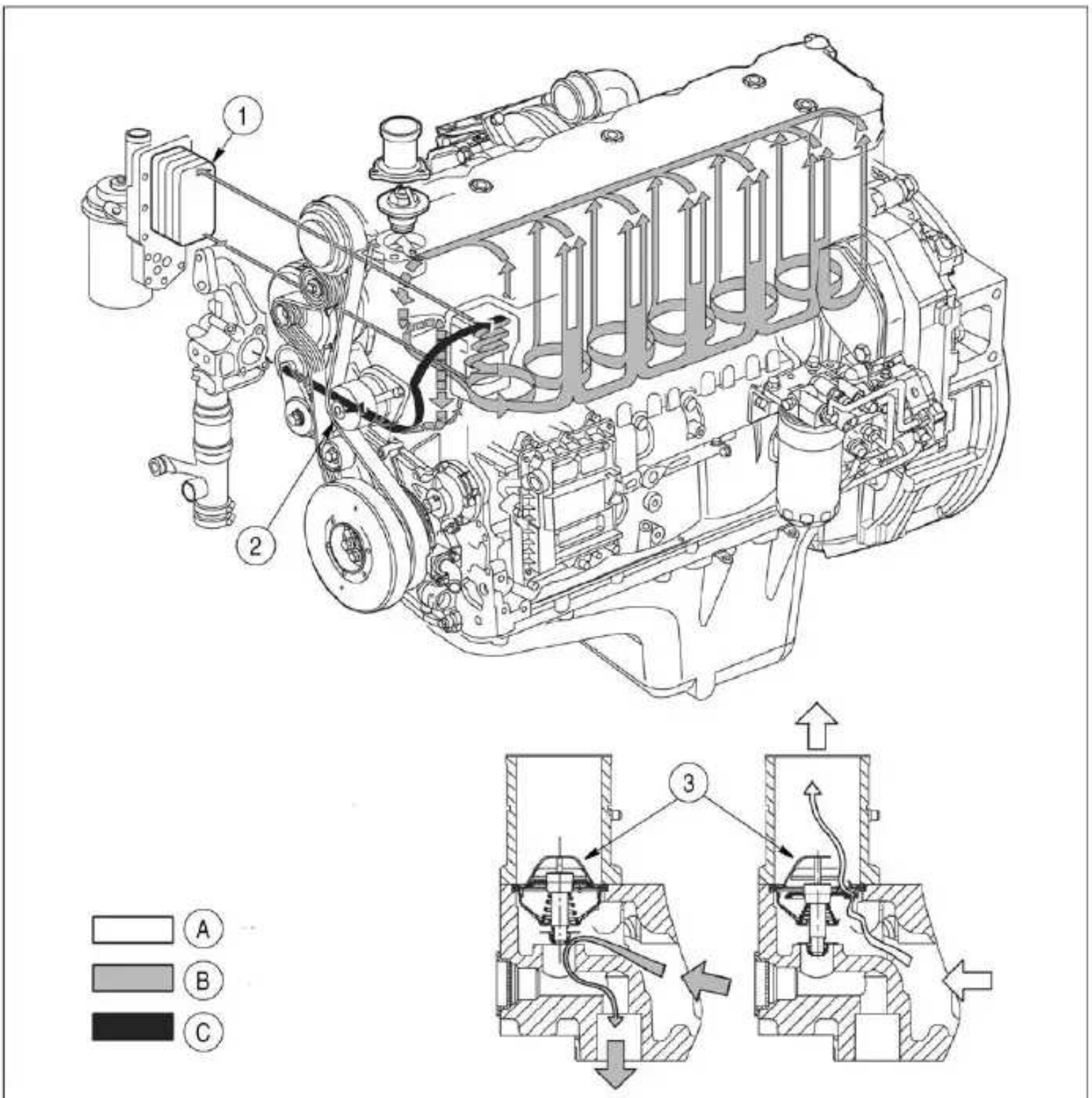


1. Pre - separator	3. Blow-by Filter	A Oil Condensate
2. Recirculation to intake	4. Return to engine	B Oil Vapors
NOTE: it is recommended to replace the Blow-by filters with every engine oil change. Crankcase pressure will increase and effect Steering pump operation if filters become plugged. Part #2992447 includes 2 filters and a gasket.		

COOLING

The engine cooling system is a closed circuit forced circulation type composed of the following components:

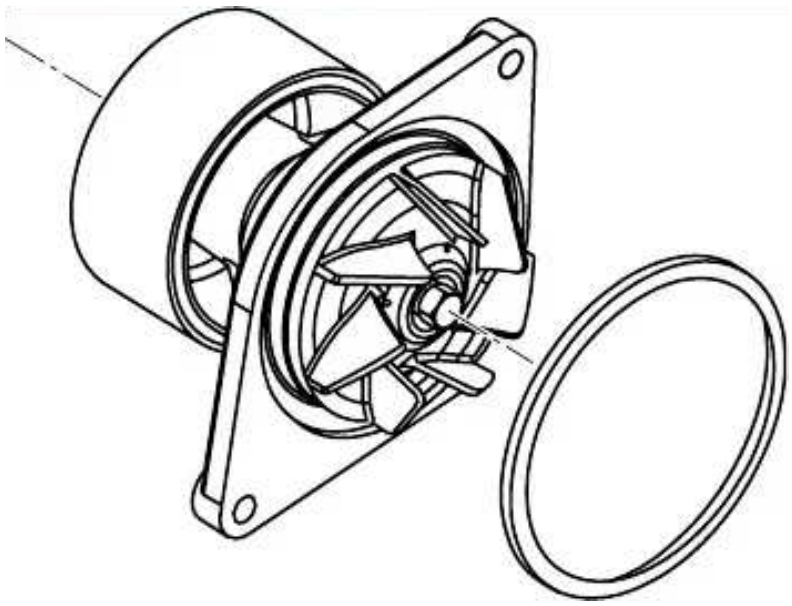
- Oil cooler to cool lubricating engine oil (see lubrication);
- Centrifugal water pump housed at the front of the block;
- Thermostat controlling coolant circulation.



1. Oil Cooler	3. Thermostat	B. Water re-circulating in Engine
2. Water Pump	A. Water from Thermostat Outlet	C. Water to Pump Outlet

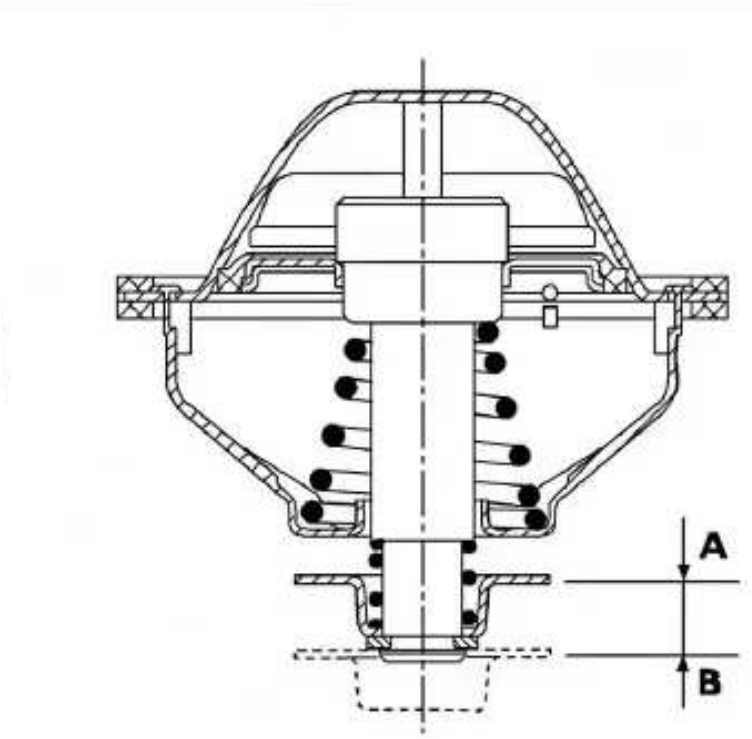
Water pump

The water pump, installed in a cavity in the front of the block, is driven by a Poly – V belt. The water pump is sealed to the block by a rubber ring.
The almost total absence of external pipes, hoses and hose clamps eliminates the number of connections and reduces possible sources of leaks.
The engine temperature is controlled by a thermostat.
The coolant (a 50% water and permanent antifreeze solution) also circulates in the oil cooler.



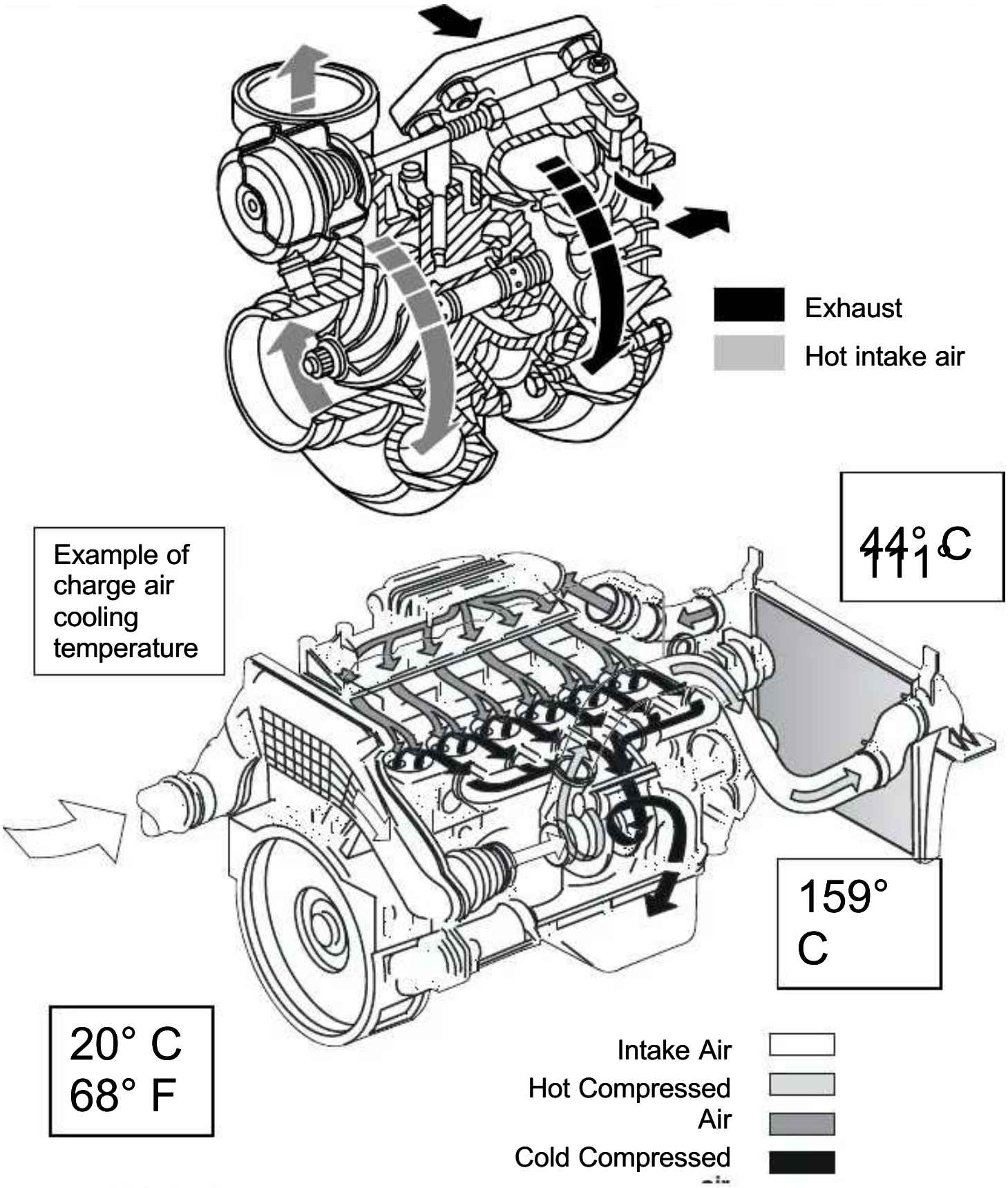
Thermostat

The thermostat opens at the following temperatures
EEG, EEC, EBF, EED, EBD = 79 to 83°C (174 to 181°F)
EDJ = 83 to 98°C (181 to 208°F)
Stroke = 7.5 mm (0.30 inches)



Turbocharger

The air intake system consists of a Holset HX3530521 Non waste-gate turbocharger and an air to air after cooler. (The picture below is not an actual Tier 3 turbocharger)



High pressure electronic injection system (common rail)

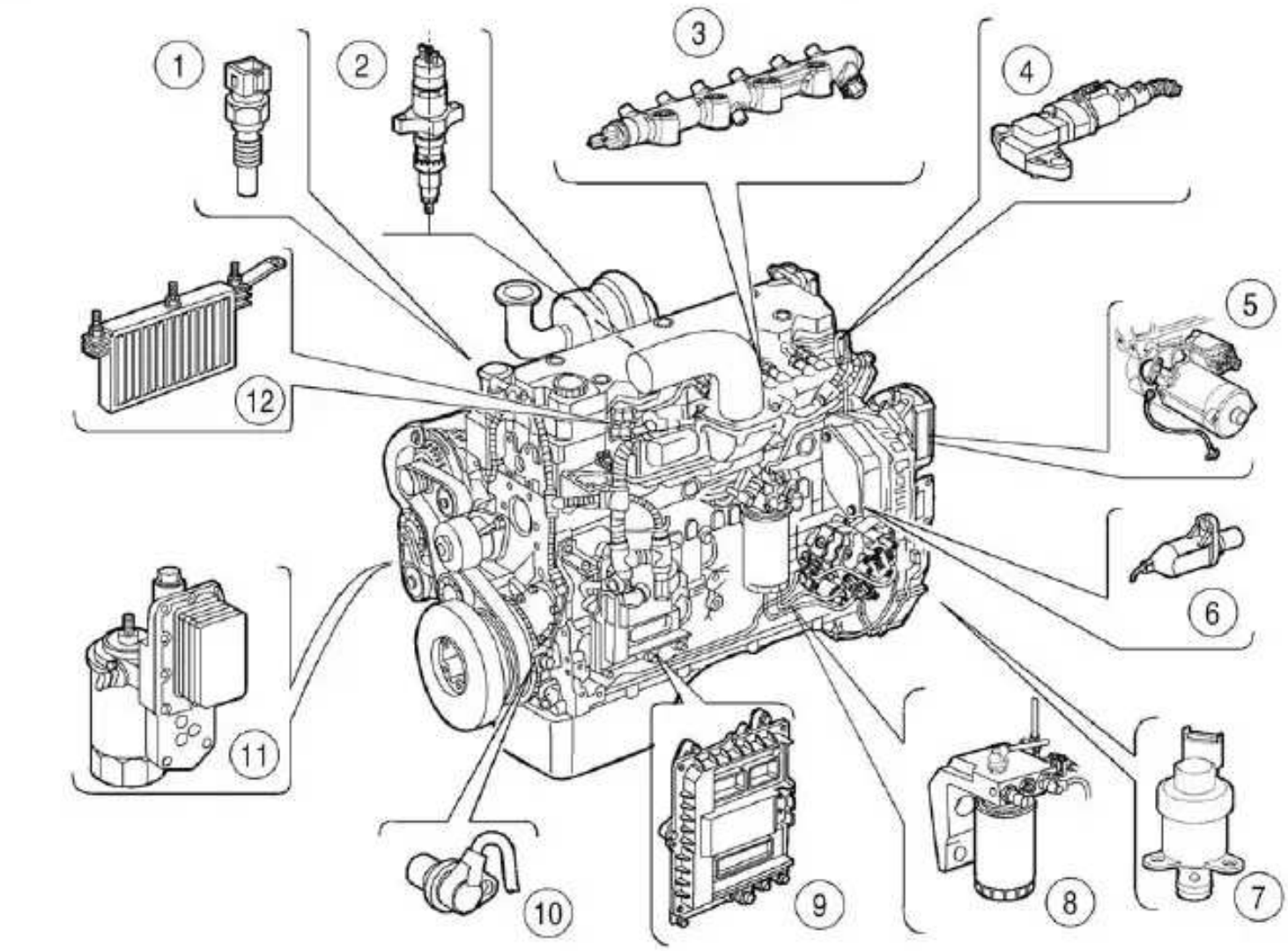
The injection system is composed of two parts which are the following

- Electrical
- Hydraulic

Extremely high injection pressures are necessary in order to reduce PARTICULATE exhaust emissions.
The common rail system makes it possible to inject fuel at pressures of up to 1600 bar (23200 psi), while the injection precision obtained by electronic control of the system serves to optimize operation of the engine while limiting emissions and fuel consumption.
For engines more powerful than 152 kW, the CRIN 2 injectors have DLLA nozzles that work up to a pressure of 1600 bar, while engines with less power are fitted with CRIN 1 nozzles which operate at pressures up to 1450 bar.

Electrical Components

The electronic control unit monitors engine control parameters by means of the various sensors on the engine.



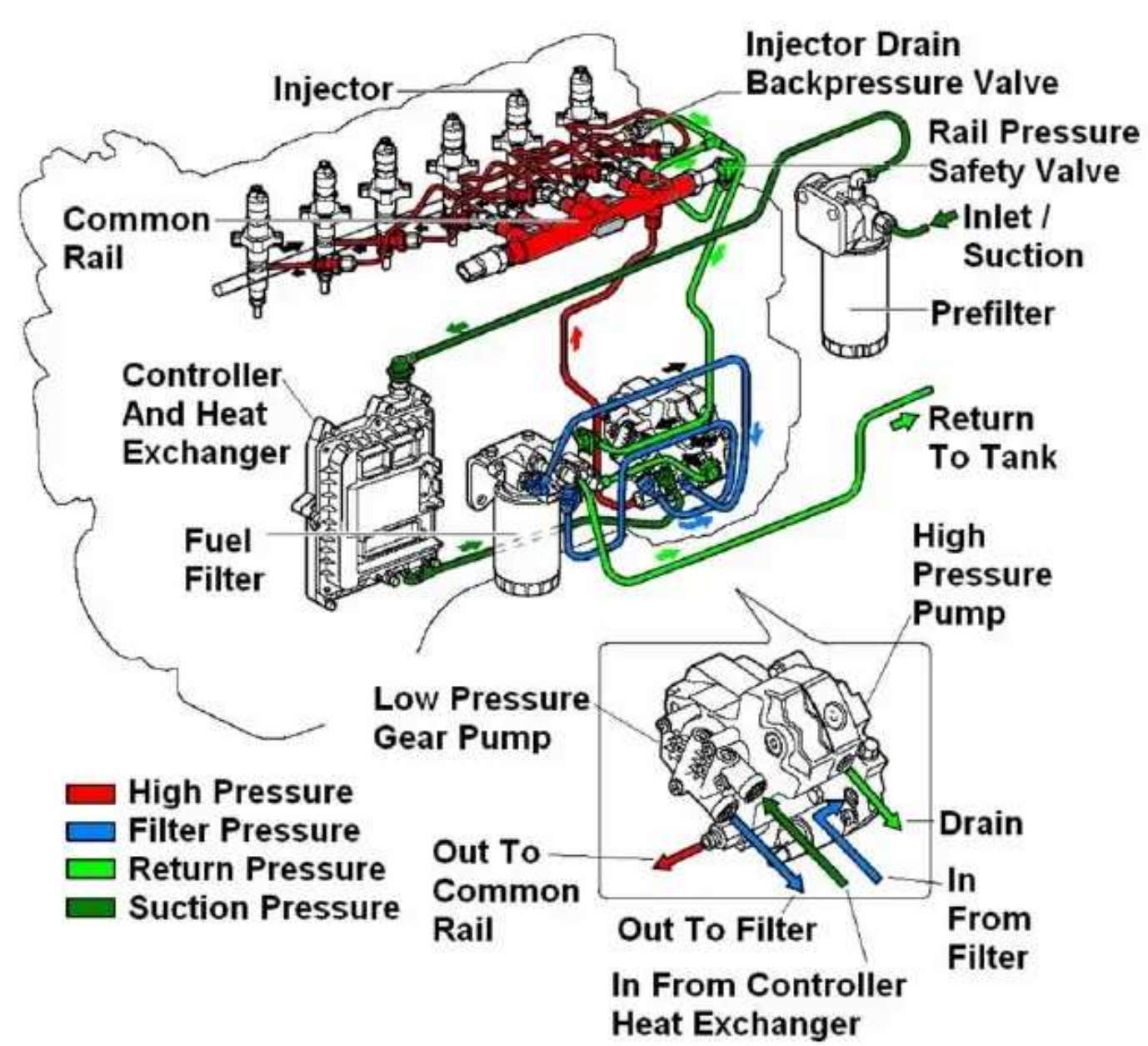
Location

Ref.	Description
1	Coolant temperature sensor
2	Electro-injector
3	Common Rail pressure sensor
4	Boost pressure/temperature sensor
5	Starter motor
6	Camshaft timing sensor
7	High pressure regulator solenoid valve
8	Fuel temperature sensor
9	EDC7UC31 electronic control unit
10	Crankshaft speed and timing sensor
11	Engine oil level transmitter (*) – optional by application
12	Engine oil pressure/temperature sensor
13	Intake air pre-post start heater grid

(*) Depending on the application

Hydraulic Components – Common Rail System

This system features a high pressure pump that maintains the fuel supply at a very high pressure depending on the speed and load of the engine. The high pressure fuel is stored in a pipeline (the "common rail") that is shared by all electro injectors. There is always a supply of fuel available at the electro injector inlet (at the injection pressure determined by the ECM). When the solenoid valve of one of the injectors is energized by the ECM, fuel arriving directly from the common rail is injected into the corresponding cylinder.



The fuel system is composed of a low pressure and a high pressure circuit.
The high pressure circuit is composed of the following pipelines:

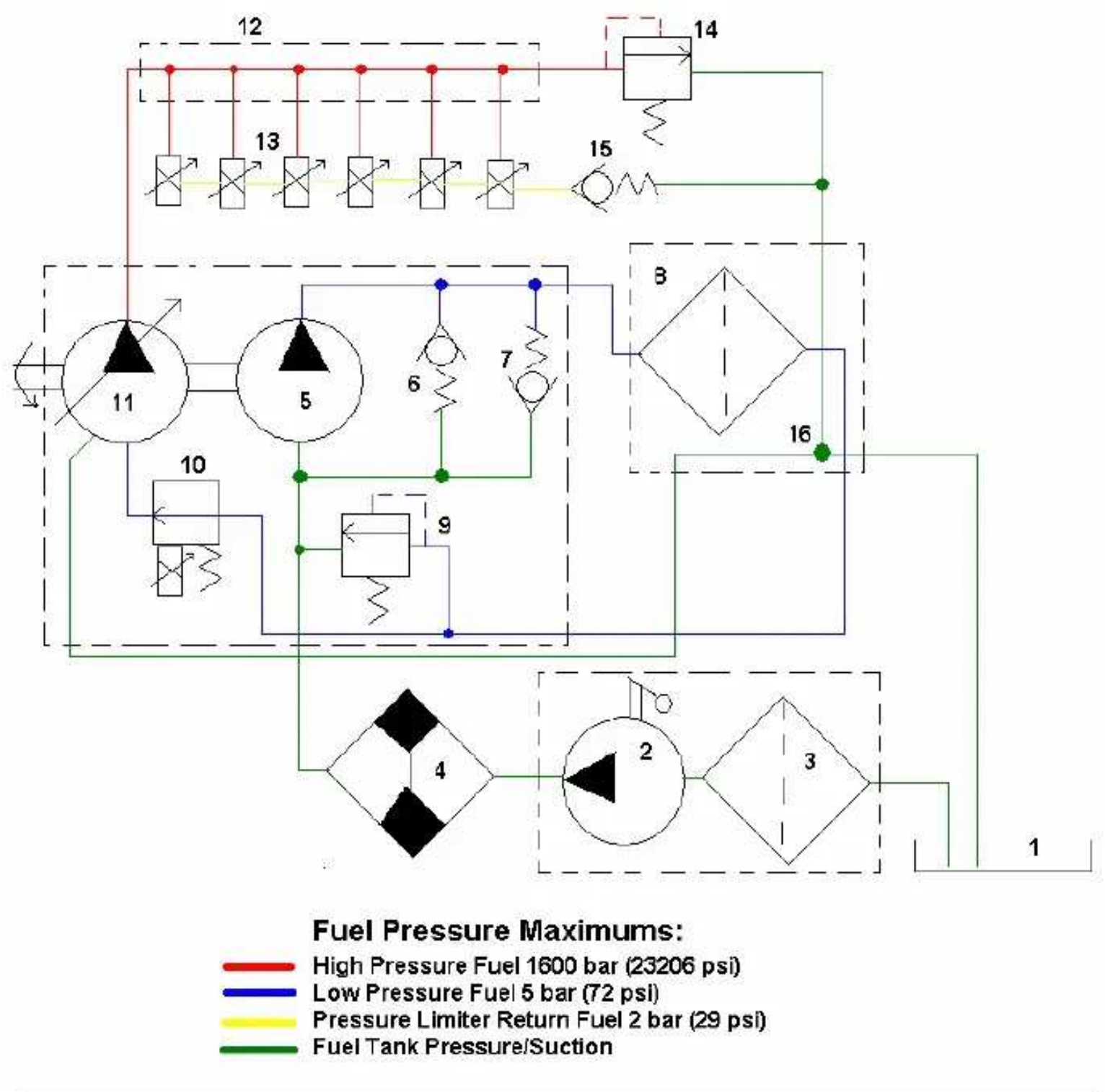
- Pipe connecting the high pressure pump outlet to the common rail;
- Pipes from the common rail to the electro injectors.

The low pressure circuit is composed of the following pipelines:

- Fuel pipe from fuel tank to pre-filter;
- Pipes supplying the gear type charge feed pump via the control unit heat exchanger, the manual priming pump and the pre-filter;
- Pipes supplying the high pressure pump via the fuel filter.

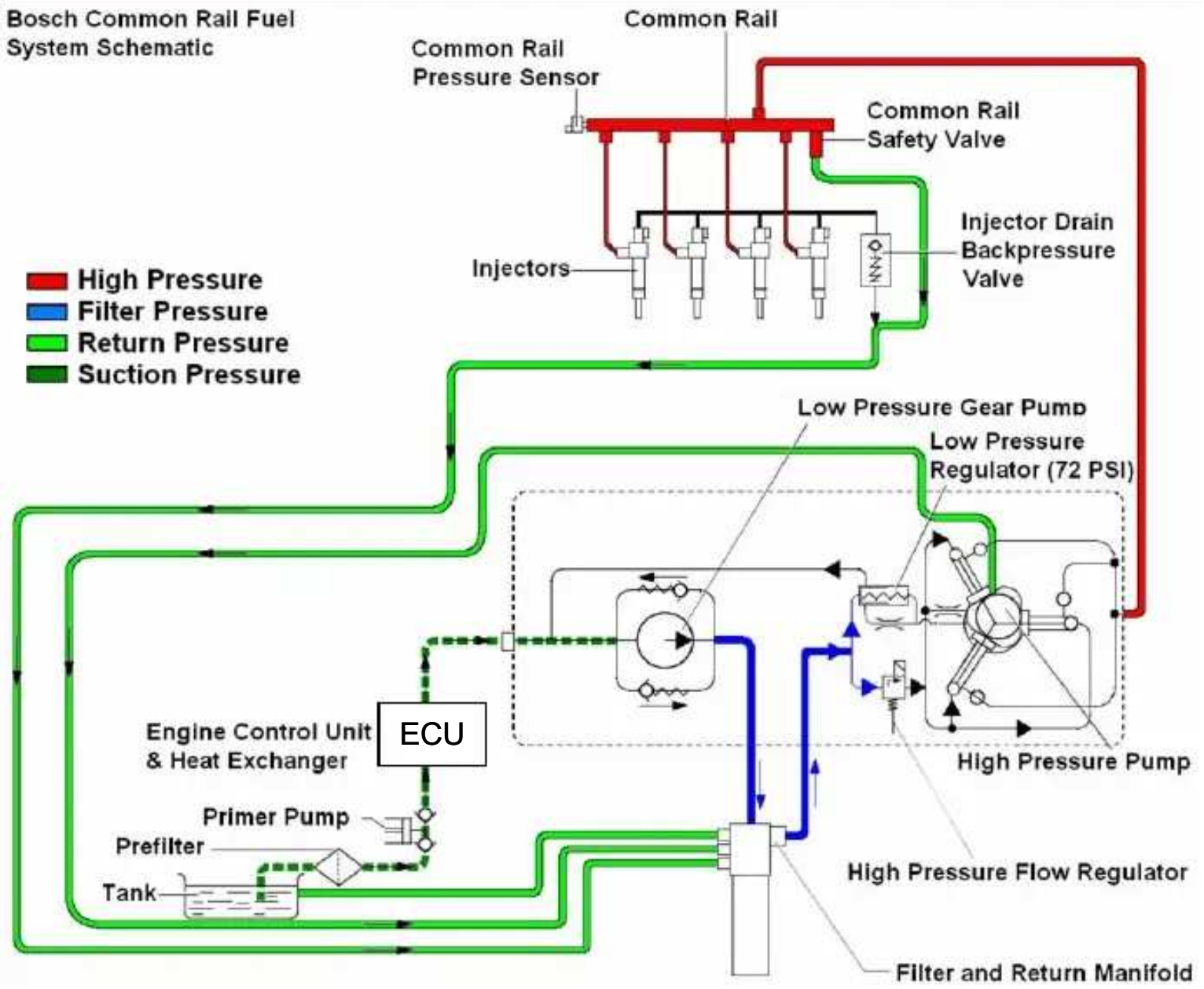
The fuel system is completed with a circuit to drain fuel from the common rail and the injectors, and a drain for the high pressure pump cooling circuit.

Fuel System Diagram General



1. Fuel Tank	9. Low Pressure Regulator Valve 5 bar (72 psi)
2. Hand Priming Pump (filter head)	10. High Pressure Regulator
3. Pre-filter	11. Radial Piston High Pressure Pump
4. EDC7UC31 Heat Exchanger Plate	12. Common Rail
5. Low Pressure Gear Pump	13. Injector Solenoids (4 or 6)
6. Safety Valve 9 bar (130 psi)	14. Common Rail 2 Stage Relief Valve 1600 bar (23,206 psi)
7. Priming Check Valve	15. Pressure Limiter Return Fuel 2 bar (29 psi)
8. Main Fuel Filter	16. Common Return Manifold (filter-head)

Fuel Supply System Diagram F4HE Engines



Normal Operation: (fuel flow)

The Low Pressure Pump (5) pulls fuel from the fuel tank (1) through the pre-filter (3)/hand priming pump (2) and EDC7UC31 Engine Controller Heat Exchanger to the low pressure pump inlet. The low pressure pump sends flow through the Main Filter (8) teed off to the Low Pressure Regulator (9) and then through the High Pressure Regulator (10) to the High Pressure Pump (11). The high pressure pump sends flow to the Common Rail (12), Injectors (13), and the Common Rail 2 Stage Relief Valve (14).

There is always a minimal leakage or return from each of the injectors. This fuel return is ported through the engine head and to the rear of the engine to the Pressure Limiter Valve (15). This return fuel then combines with any return flow from the Common Rail 2 Stage Relief Valve (14) (should be no flow) and the return flow from the high pressure pump (minimal flow) in the Common Return Manifold (16) and returned to the fuel tank. The individual components are covered in greater detail in the following pages.

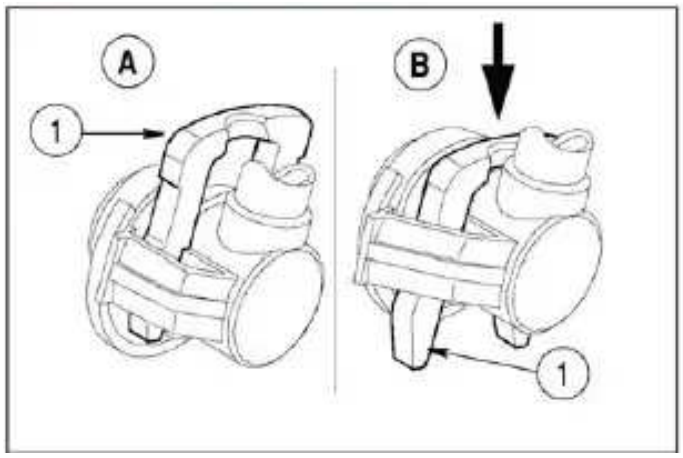
Control of Common Rail Pressure: (injection pressure)

The EDC7UC31 controls common rail pressure by pre-determined values for the common rail pressure setpoint or the ideal common rail pressure for a given operating condition. Common rail pressure setpoint is determined by several input variables to the EDC7UC31: engine speed, engine load, throttle position, fuel temperature, air temperature, oil temperature, coolant temperature, boost pressure, and oil pressure. The fuel pressure sensor is the input signal to the EDC7UC31 to know if the correct output signal was sent to the high pressure regulator.

The EDC7UC31 Engine Controller monitors all of the electrical sensors to determine the necessary signal to control the High Pressure Regulator. When the rail pressure is lower than required, the controller does not send a signal to the normally open High Pressure Regulator Pulse Width Modulated (PWM) Solenoid on the inlet to the high pressure pump. This allows for full inlet flow to the high pressure pump. The high pressure pump is then able to send full flow to the common rail. With full flow to the common rail, the rail pressure increases. Meanwhile, the EDC7UC31 electrically controls the firing order, timing, and duration of the injector pulses by the signals sent to each of the injectors. Once the EDC7UC31 senses enough rail pressure for the application, the EDC7UC31 sends power to the PWM solenoid on the High Pressure Regulator to limit the inlet flow to the high pressure pump. Since the inlet flow is now restricted, the common rail pressure is now maintained at a higher pressure. When the rail pressure is higher than required for the application, the EDC7UC31 sends full power to the PWM solenoid to completely close off the inlet to the high pressure pump. This allows for the rail pressure to decrease since there is no more flow going into the common rail and the injectors continue to fire or remove fuel from the high pressure circuit.

WARNING: Never fill the fuel filters prior to installing the filter. Always use the hand pump to prime the fuel system when replacing fuel filters or repairing the fuel system. Fuel that is poured directly into the filter, bypasses the filter and can cause damage to the fuel system components due to contamination.

The low pressure fuel line connectors are of a quick disconnect type. ‘A’ illustrates the locked position and ‘B’ illustrates the unlocked position. (1) is the U-shaped locking device.



IMPORTANT: Always make sure the suction side lines are seated and locked properly. If the lines are loose, air can enter the system and result in poor performance of the engine.

REMEMBER: In the suction side of a circuit, air can leak into the system before fluid will leak out of the system.

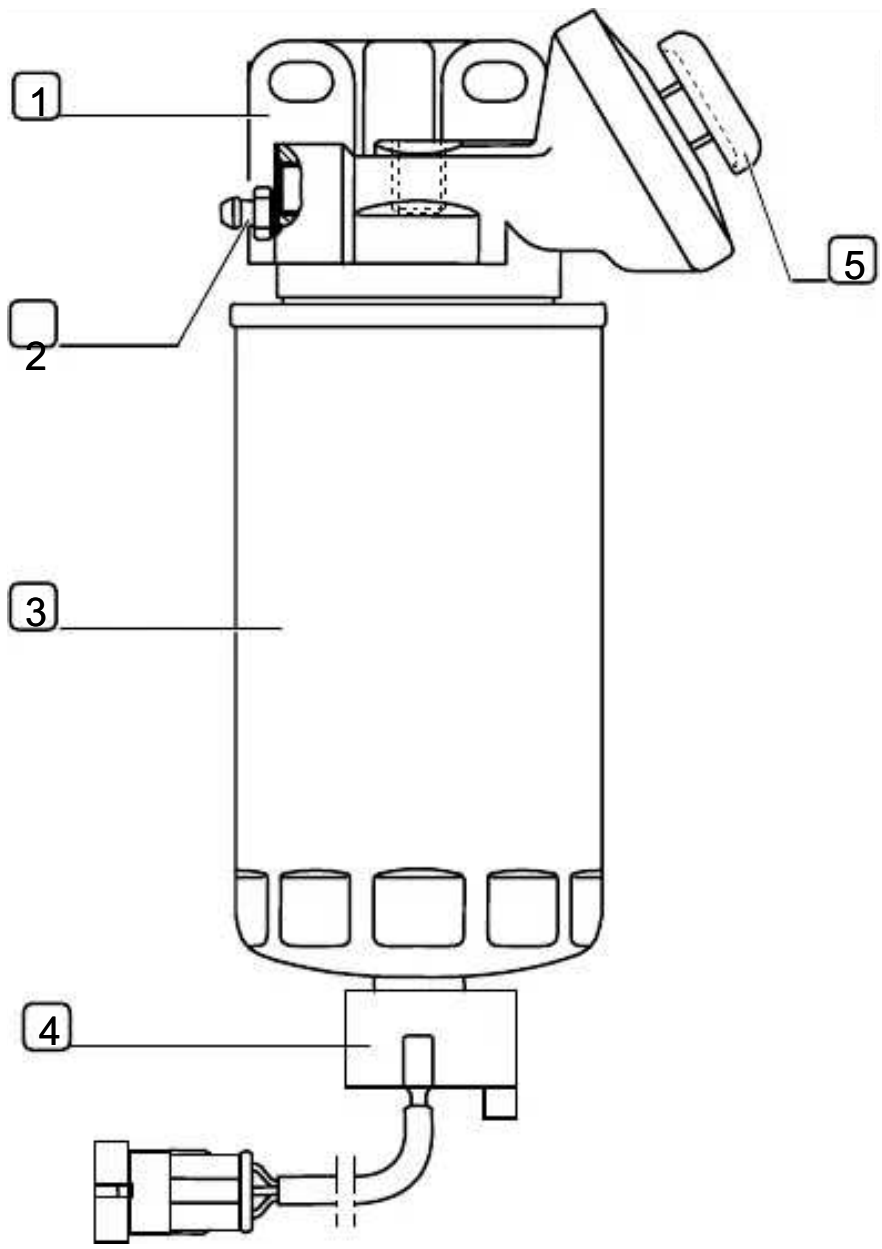
Main Mechanical Components of the Fuel Supply System

Fuel Pre-filter

The fuel pre-filter assembly, with a water shedding media, features a sensor (4) at the bottom of the cartridge (3), responsible for signalling the presence of water in the fuel. The filter support incorporates the manual priming pump (5) and a fuel system air bleed screw (2).

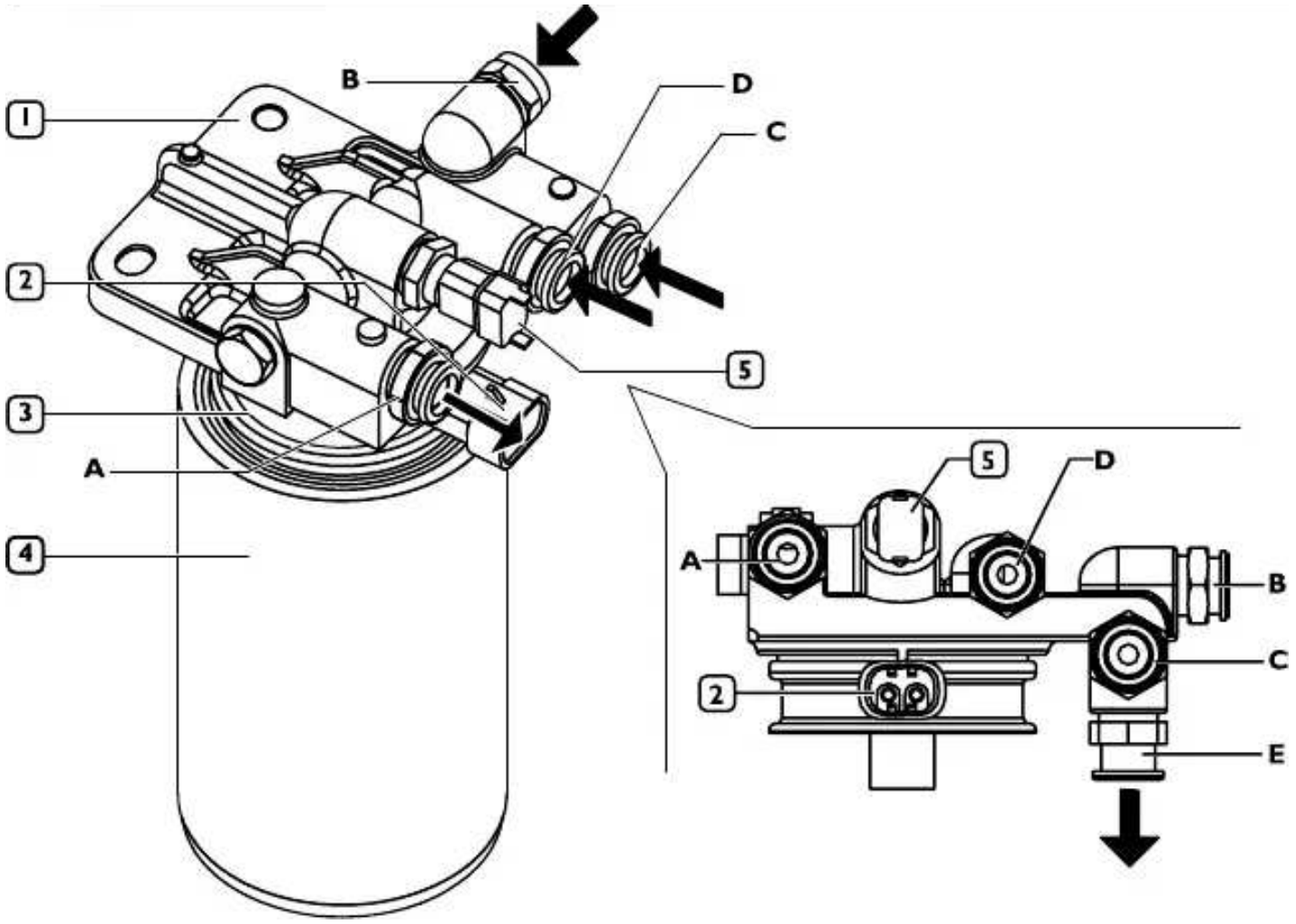
Warning

If the fuel water contamination warning light illuminates, act instantly to remedy the cause; the components of the common rail system will be rapidly damaged if the fuel contains water or other impurities.



Fuel filter

The fuel filter is located on the engine crankcase in the fuel circuit between the gear charge feed pump and the high pressure pump.
The fuel temperature sensor (5) and fuel heater (2) are located on the support
The heater is activated if the fuel temperature is < = 0° C (32° F) and it continues to operate until the fuel reaches + 5° C (41° F).
Monitoring the fuel temperature, by the EDC7UC31 control unit, enables highly accurate calculation of the flow rate of fuel to inject into the cylinders.



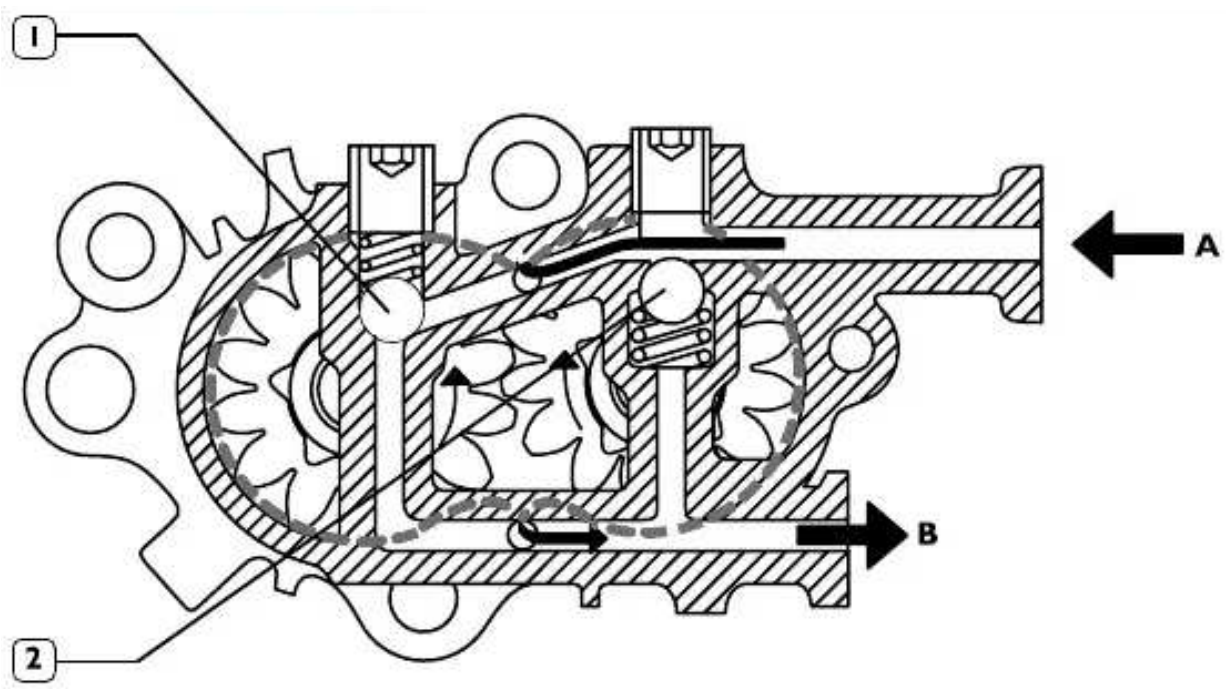
1. Fuel filter support	A. Outlet connection to high pressure pump
2. Fuel heater connector	B. Common rail and cylinder head (injectors) discharge line inlet connection
3. Electric fuel heater	C. Connection to high pressure pump discharge line.
4. Fuel filter	D. Inlet connection from feed pump
5.. Fuel temperature sensor	E. Outlet connection to fuel tank

Gear Charge Feed Pump

Charge Feed Pump

Normal operating condition

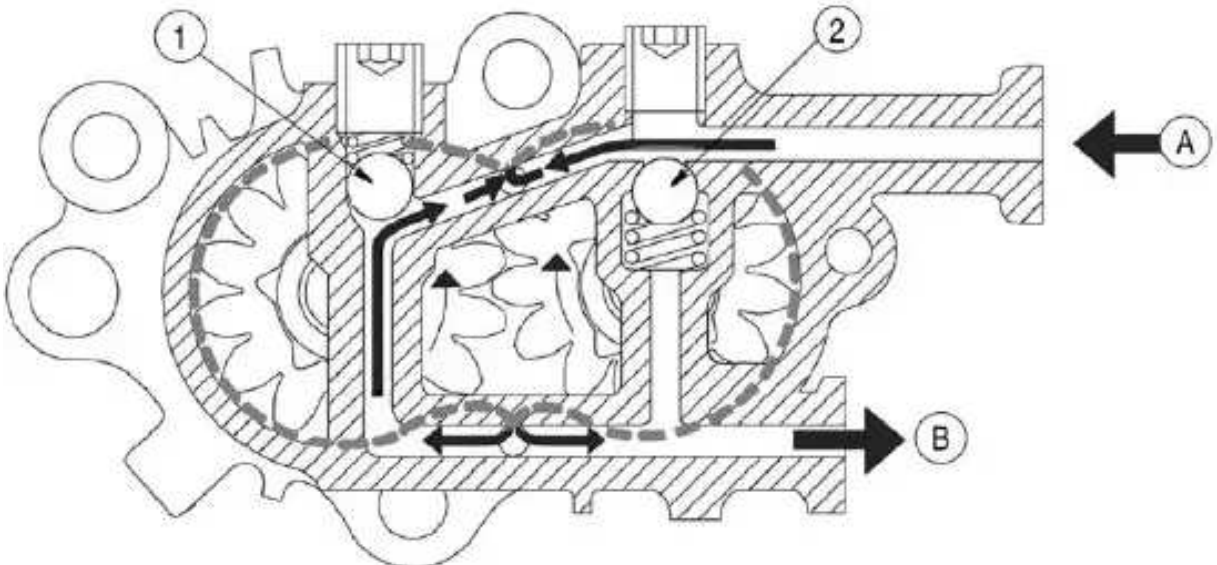
The charge gear feed pump, installed on the rear of the high pressure pump, draws fuel from the tank through the pre-filter and sends it through the main fuel filter to the high pressure pump. The feed pump is driven by the high pressure pump shaft.
In normal operating conditions the flow of fuel in the feed pump enters port (A), flows around the outside of the gears and out through port (B).



A. Fuel inlet from tank	1. Pressure safety valve
B. fuel outlet to filter	2. Priming by-pass valve in closed position

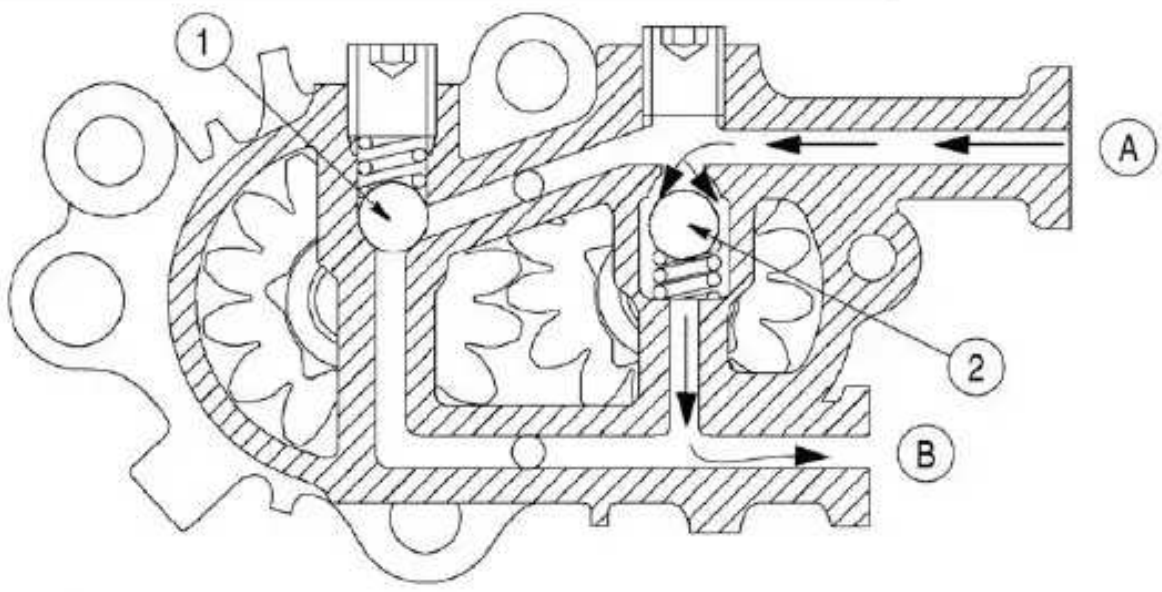
Outlet overpressure condition

Pressure safety valve (1) opens when the pump outlet pressure (B), is excessive due to filter restriction or charge pressure regulator malfunction. The pressure of the fuel would then overcome the force exerted by spring (1) thereby connecting the pump to the inlet by way of passage (2).



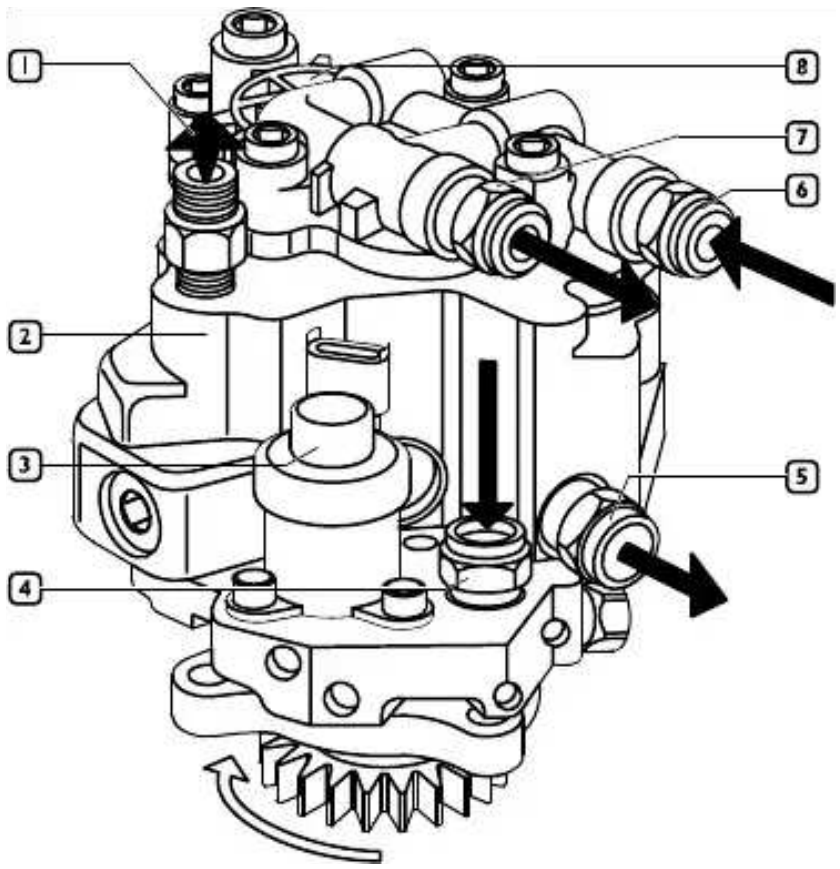
Fuel System Bleeding

The by-pass check valve (2) opens when, with the engine stopped, the fuel circuit must be filled using the manual priming pump on the pre-filter. Activating the priming pump on the pre-filter, the by-pass check valve (2) opens, allowing the fuel to flow out of outlet (B).



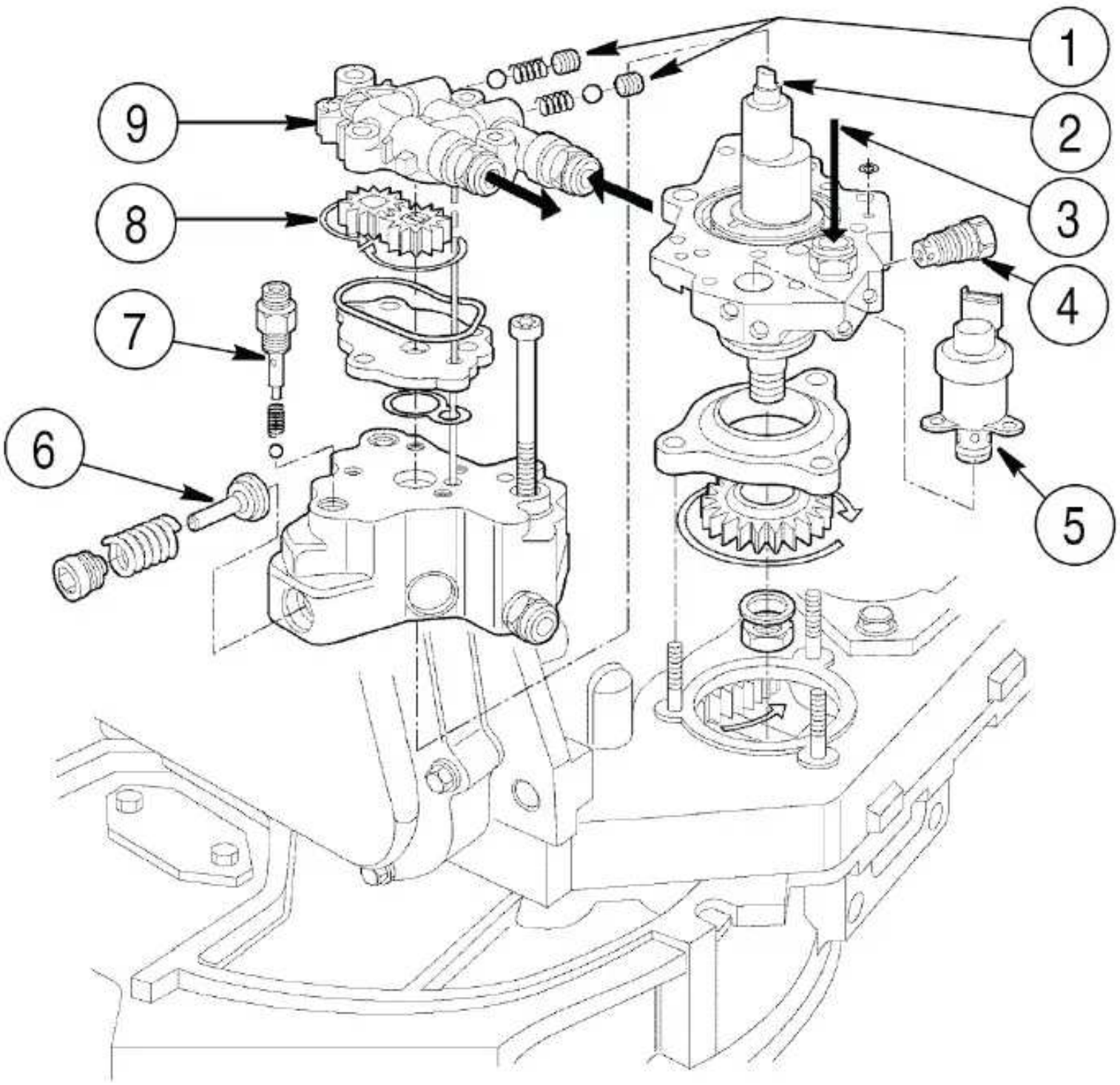
High Pressure Pump

The high pressure pump has 3 radial plungers driven by the cam gear. The high pressure pump does not require timing. The rear of the high pressure pump is fitted with the mechanical gear feed pump, which is driven by the high pressure pump shaft.



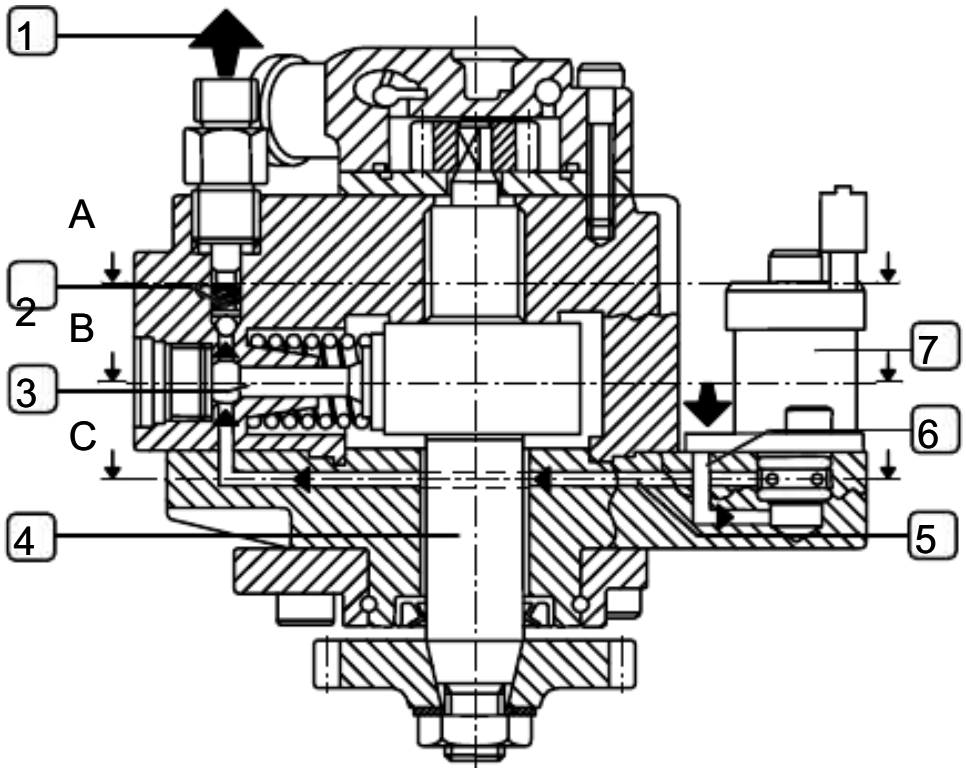
1. Fuel outlet connection to rail	5. Fuel drain return connection to filter support
2. High pressure pump	6. Gear pump fuel inlet connection from control unit heat exchanger
3. High pressure regulator	7. Fuel outlet connection from mechanical pump to filter
4. Fuel inlet connection from filter	8. Mechanical gear charge feed pump.

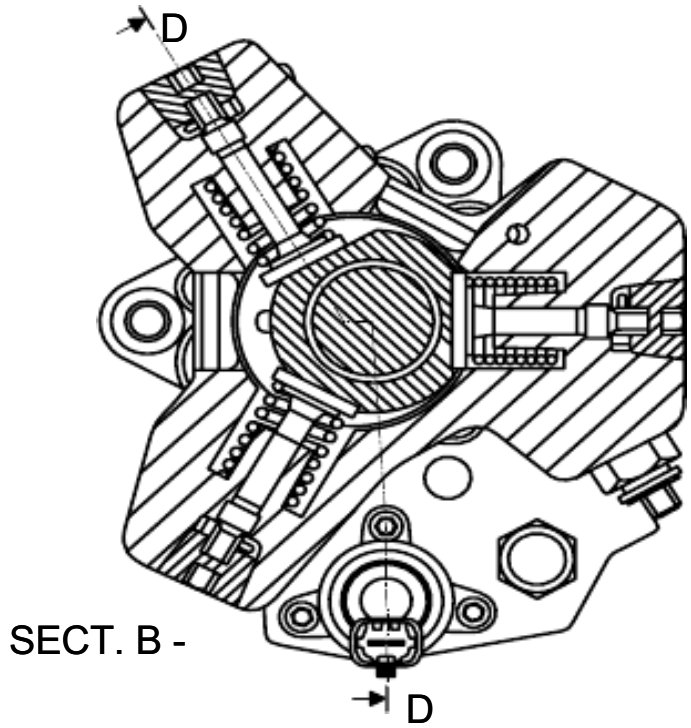
NEF TIER 3 ELECTRONIC ENGINE



1. By-pass valves on feed pump	4. 5.Bar (72 PSI) Low Pressure Fuel Regulator Valve	7. High Pressure Fuel Delivery Valve to Common Rail
2. Pump Shaft	5. High Pressure Regulator Solenoid Valve	8. Gear Set
3. High Pressure Pump Fuel Inlet From Filter	6. Individual High Pressure Plunger (1 of 3)	9. Mechanical Gear Charge Feed Pump

Operating principle



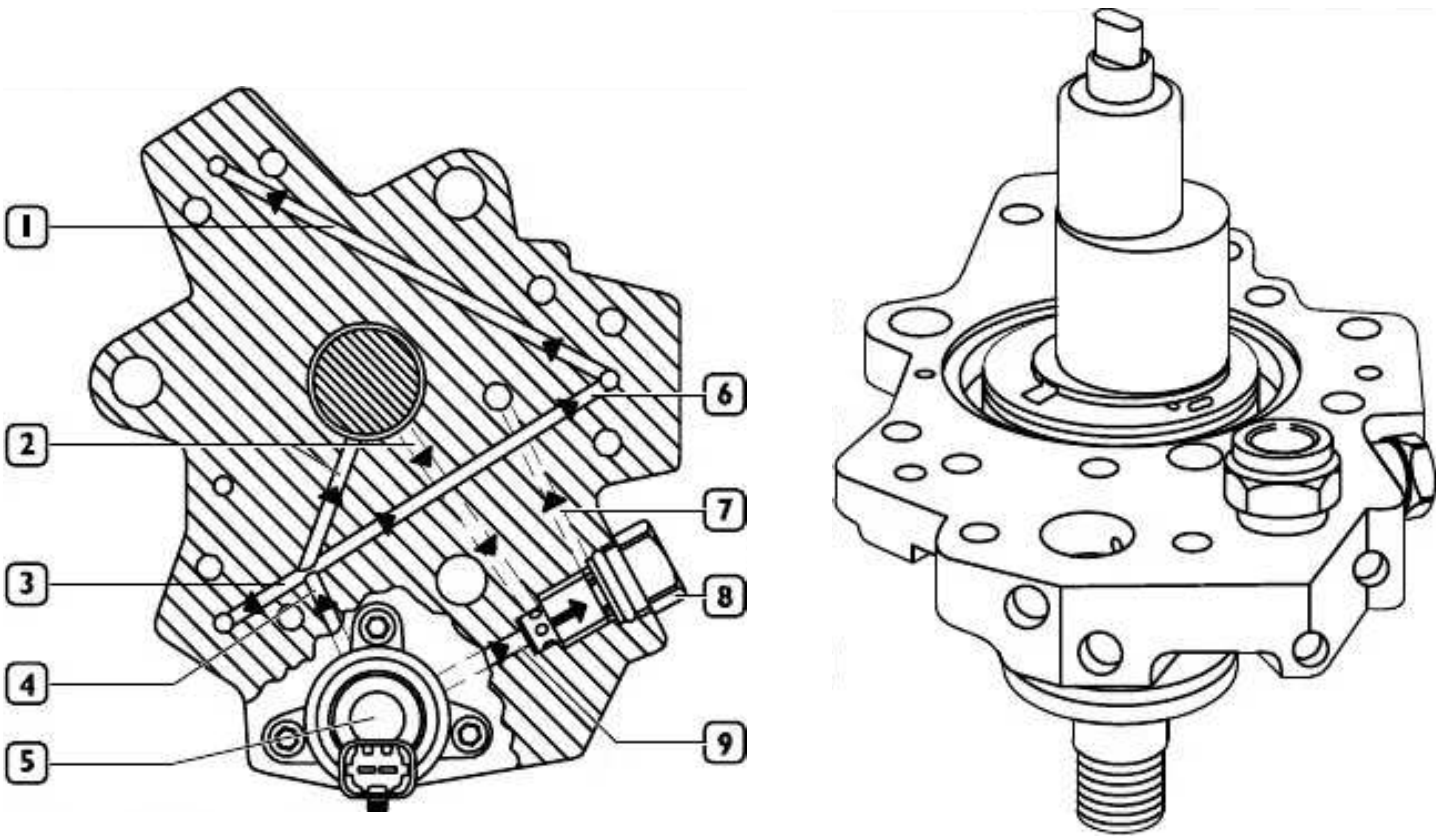


1. Outlet for rail delivery line	5. Plunger supply passage
2. Rail delivery valve	6. Pressure regulator supply passage
3. High pressure plunger	7. High pressure regulator.
4. Pump shaft	

Plunger (3) rides on the cam mounted on the pump shaft.
In the intake phase the plunger is supplied with fuel through the supply passage (5).
The quantity of fuel to supply to the plunger is determined by pressure regulator (7). The pressure regulator controls high pressure pump outlet flow based on a PWM (pulse width modulated) command received from the control unit. During the plunger

compression phase the fuel reaches sufficient pressure to open the common rail delivery valve (2) and is thus forced through outlet (1) to the common rail.

The figure (sect c-c), shows the low pressure fuel passages inside the pump; the figure shows the main plungers supply passage (4), the individual plunger supply passages (1, 3, & 6), the passages utilized for lubrication of the pump (2), the high pressure regulator (5), the 5 bar (72 psi) pressure regulator valve (8) and the fuel discharge passage (7).
The pump shaft is lubricated by fuel through delivery and return passages (2).
The high pressure regulator (5) determines the quantity of fuel which the high pressure plungers deliver to the common rail; excess fuel flows out through passage (9).
The 5 bar (72 psi) regulator valve, apart from functioning as a manifold for fuel discharges, is designed to maintain a constant pressure of 5 bar (72 psi) at the high pressure regulator inlet.

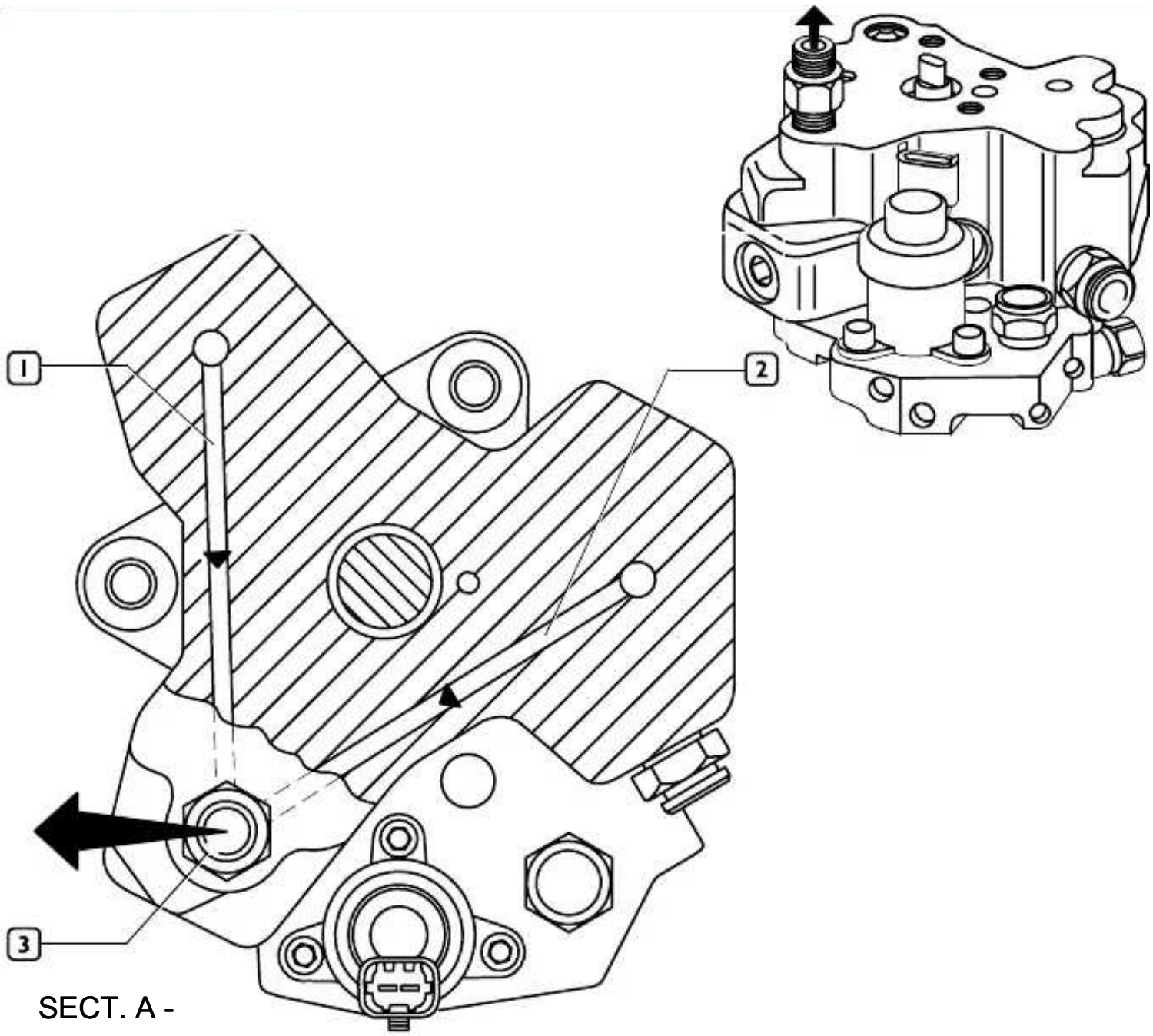


SECT. C -

1, 3, 6. Inlet to high pressure plungers

2. Pump lubrication passages
4. Main plungers supply passage
5. High pressure regulator valve
7. Charge pressure regulator drain passage
8. Supply pressure 5 bar (72 psi) regulator valve
9. Fuel Discharge from high pressure regulator valve inlet

The figure (sect A-A), shows the high pressure flow of fuel through the plunger outlet passages.



SECT. A -

1, 2. Fuel outlet passages.
3. Fuel outlet from pump with connection for high pressure line to common rail.

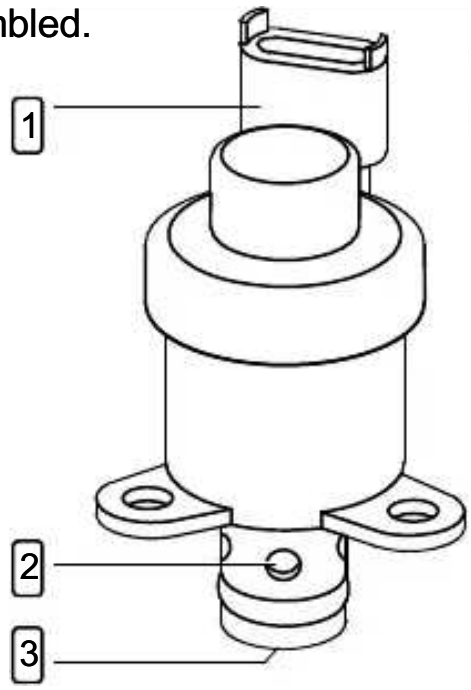
High Pressure Regulator

The high regulator is located at the inlet to the high pressure pump and controls the output flow of the high pressure pump in order to regulate the pressure of the fuel stored in the common rail, based upon instructions from the EDC7UC31.

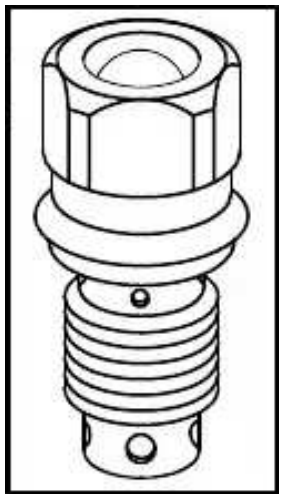
The regulator is basically composed of the following parts:

- poppet
- core (control)
- pre-load spring
- coil

In the absence of a control signal, the pressure regulator is normally open so the high pressure pump operates at maximum flow.
The engine control unit transmits a PWM (pulse width modulated) signal to the regulator to vary the outlet flow of the high pressure pump.
This component cannot be replaced independently and therefore must not be disassembled.



1. Electrical connector
2. Fuel outlet
3. Fuel inlet



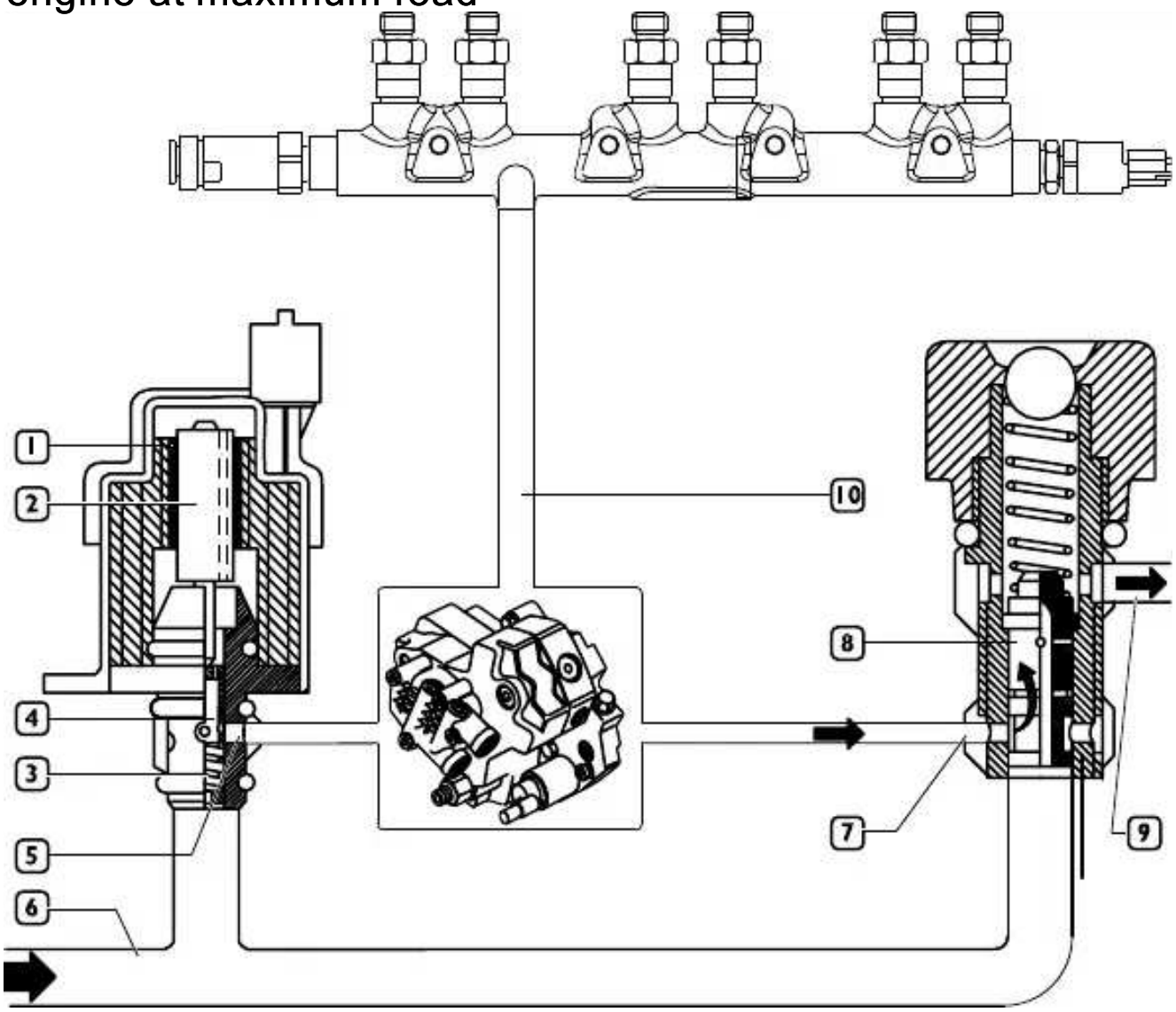
Supply pressure regulator valve

Installed in parallel to the high pressure control valve, this low pressure regulator serves to maintain constant fuel pressure at the inlet to the high pressure regulator, this being a necessary for correct operation of the system.

When the high pressure control valve is partially closed at the fuel outlet by the PWM control signal, the pressure at the inlet tends to rise.

When pressure at the regulator inlet exceeds (5 bar / 72 PSI) it overcomes the resistance offered by the spring and travels upwards thereby allowing inlet flow to dump in the return line. The fuel is therefore able to flow to the drain side thus reducing the pressure at the regulator inlet so the cylinder tends to return to its closed position. In relation to engine load demands, with the pressure regulator partially closed, the cylinder assumes a position of dynamic balance such as to assure constant pressure of 5 bar at the regulator inlet.

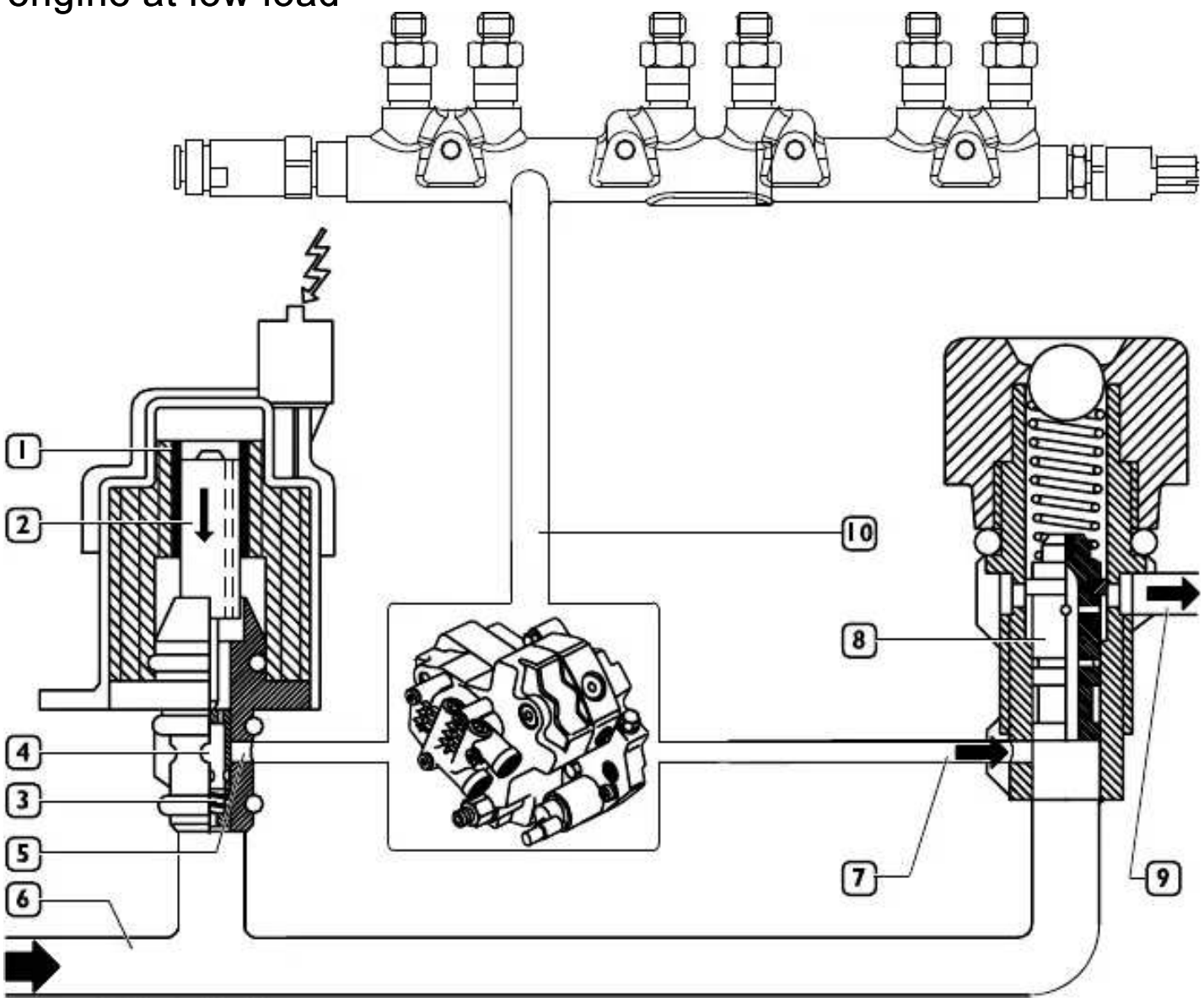
High pressure control valve and 5 bar (72 psi) regulator valve with engine at maximum load



1. Coil	6. Fuel inlet (from filter)
2. Core	7. Fuel return from high pressure pump
3. Preload spring	8. Cylinder for opening discharge port
4. Poppet	9. Fuel discharge
5. High pressure pump feed	10. Fuel delivery to Common Rail

When the regulator coil (1) is not energized, the core (2) will be in its rest position due to the preload spring (3). Poppet (4) will be in the maximum delivery position. At this time, the regulator feeds the high pressure pump with the maximum available fuel flow rate. The cylinder (8) controlling opening and closing of the 5 bar pressure limiter discharge passage is in its closed position. Clearance between the internal parts is such as to allow a minimum flow of fuel towards the outlet passage in order to lubricate the pump.

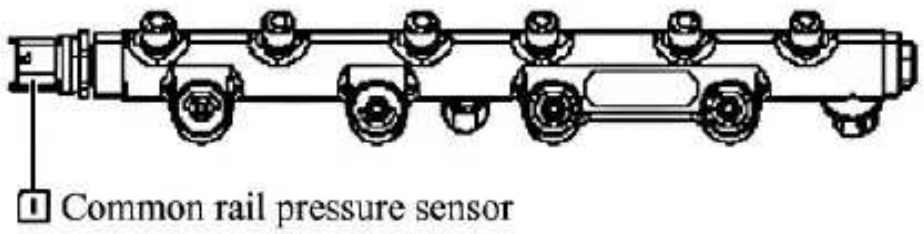
High pressure control valve and 5 bar (72 psi) regulator valve with engine at low load



1. Coil	6. Fuel inlet (from filter)
2. Core	7. Fuel return from high pressure pump
3. Preload spring	8. Cylinder for opening discharge port
4. Poppet	9. Fuel discharge
5. High pressure pump feed	10. Fuel delivery to Common Rail

When the engine is at low load, the EDC drives the high pressure regulator with a pulse width modulation (PWM) signal to energise the regulator coil and hence displace the coil core (2). In its movement, the core causes poppet (4) to assume the maximum closed position thus allowing the minimum flow of fuel to the high pressure pump.
The high pressure regulator is in its maximum closure position because the common rail must be maintained at a relatively low pressure (350 - 400 bar). Cylinder (8) of the 5 bar limiter valve, responsible for controlling opening and closing of the discharge port, will be in its max opening position to allow excess fuel to flow through discharge outlet (9).

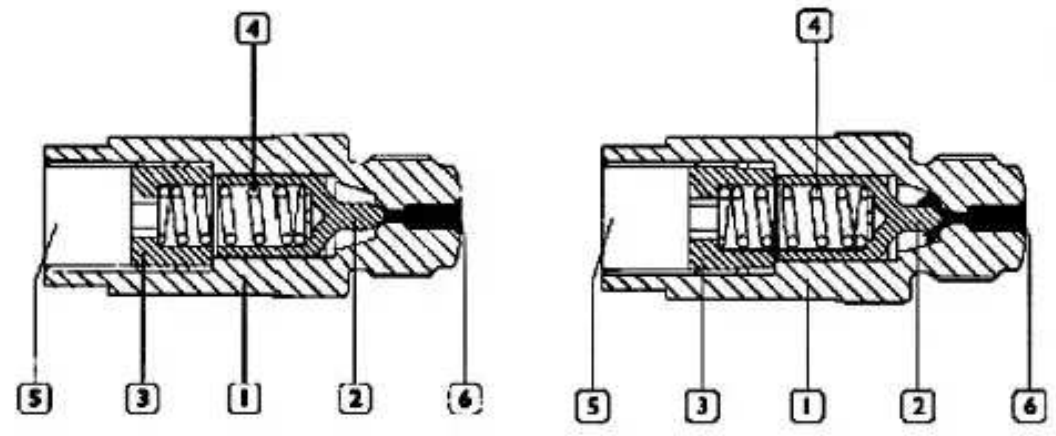
Common Rail (Pressure accumulator)



The common rail is a high pressure fuel storage device. It has a small volume to allow rapid pressurization at the time of engine starting, engine slow idling, and in the case of high flow rates.
The volume is, however, sufficient to minimize the bellows effect caused by opening and closing of the injectors and operation of the high pressure pump. This function is further aided by a calibrated orifice between the high pressure pump and the common rail.
The high pressure fuel pressure sensor (1) is screwed to the end of the common rail. The common rail pressure sensor sends a feedback signal to the electronic control unit so that the control unit can regulate the fuel delivery of the high pressure pump. The high pressure regulator valve in the high pressure pump controls the output flow. The rail pressure is modulated between 250 and 1600 bar by the electronic control unit, through the high pressure regulator solenoid valve.

Common rail pressure relief valve

This strictly mechanical valve is a dual-stage relief valve installed at one end of the common rail. It protects the system components from failure of the rail pressure sensor or of the high pressure Bosch CP3 pump pressure regulator.
If the common rail fuel pressure increases to 1750 bar (25400 psi) the dual stage relief valve opens. Once the opening pressure has been reached, the dual stage relief valve limits the rail fuel pressure to about 800 bars (11600 psi). The dual stage relief valve will automatically reset when the engine is shut down and the common rail pressure has decayed. The dual stage relief will activate again upon restart if the problems persist.
This valve enables the engine to work at a limited performance for extended periods of time and avoid excessive fuel overheating thus safeguarding the system.
When the dual stage relief valve opening pressure is reached, the control unit stops the operation of the pressure regulator. The high pressure pump will then operate at maximum delivery to the rail, and failure code 3104 (E Series), 8.4 (D series) will be stored.



1. Body 2. Small piston 3. Stop 4. Spring 5. Direct tank discharge 6. Seat on rail

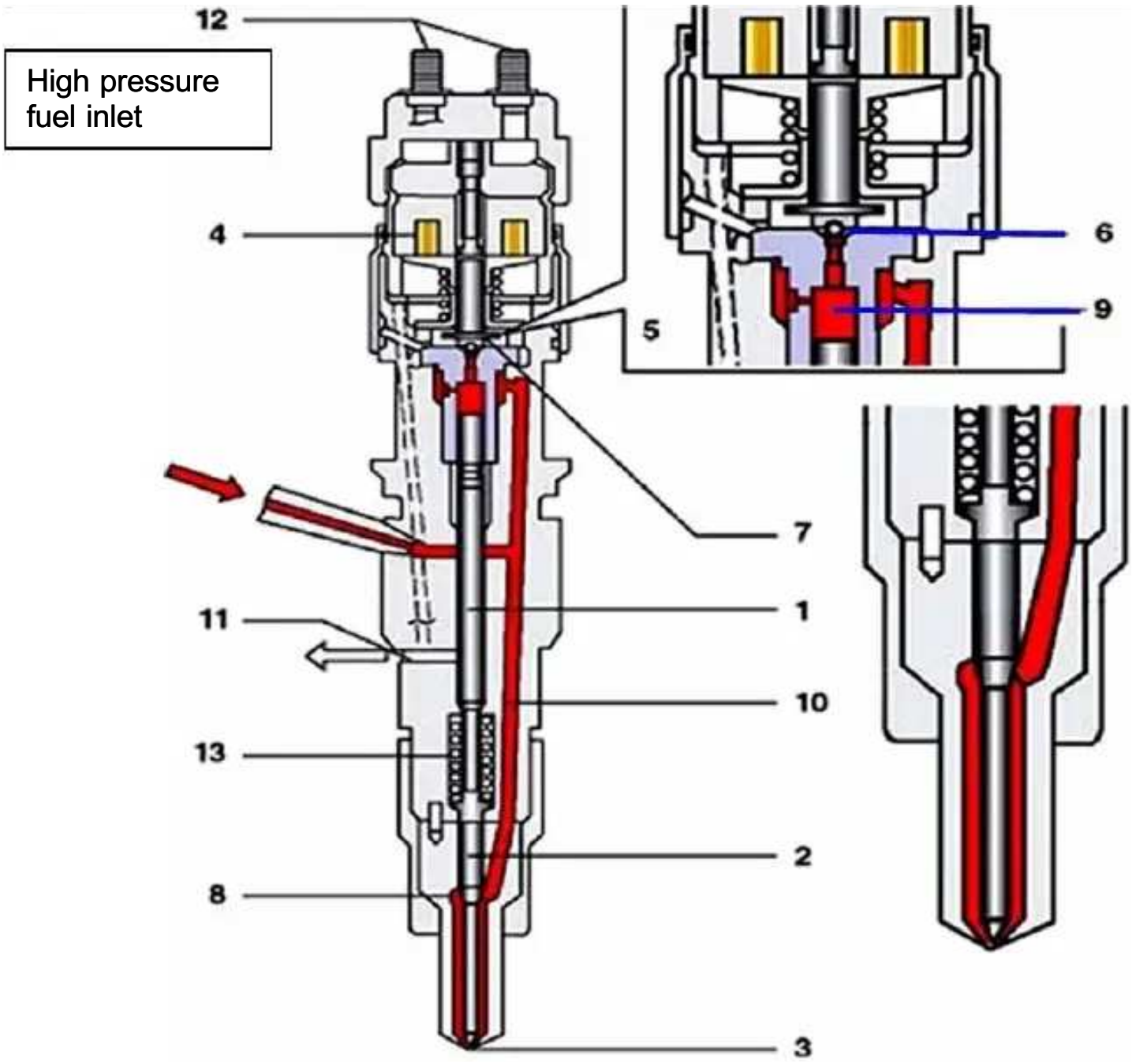
Electro Injector

The injector is similar in construction to conventional injectors, except for the absence of the needle return springs.
The electro-injector can be considered in terms of two basic parts:

- Actuator – spray nozzle composed of pressure rod (1), needle plunger (2) and nozzle (3);
- Control solenoid valve composed of coil (4) and pilot valve (5).

The solenoid valve controls lift of the jet needle.

Injector in rest position

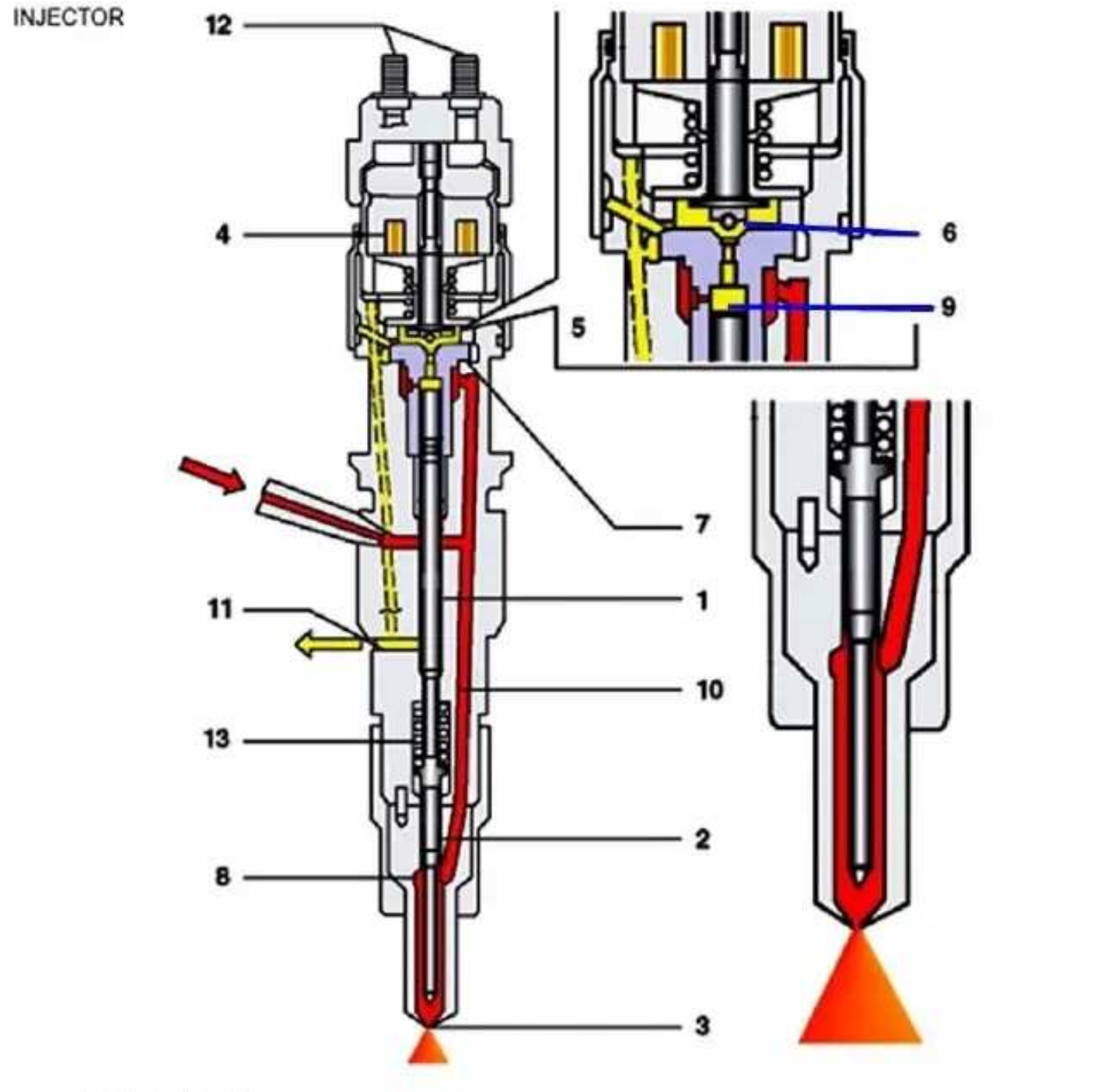


1. Pressure rod	8. Pressure chamber
2. Needle plunger	9. Control volume
3. Nozzle	10. Supply control line
4. Coil	11. Control fuel outlet
5. Pilot valve	12. Electrical connection
6. Ball shutter	13. Spring

7. Control area	

Injection Start

When coil (4) is energized, it causes an upward movement of ball shutter (6). The fuel of control volume (9) flows towards the fuel control drain passage (11) causing a pressure drop in control volume (9). At the same time the fuel pressure in pressure chamber (8) causes lifting of needle (2), causing injection of fuel into the cylinder.



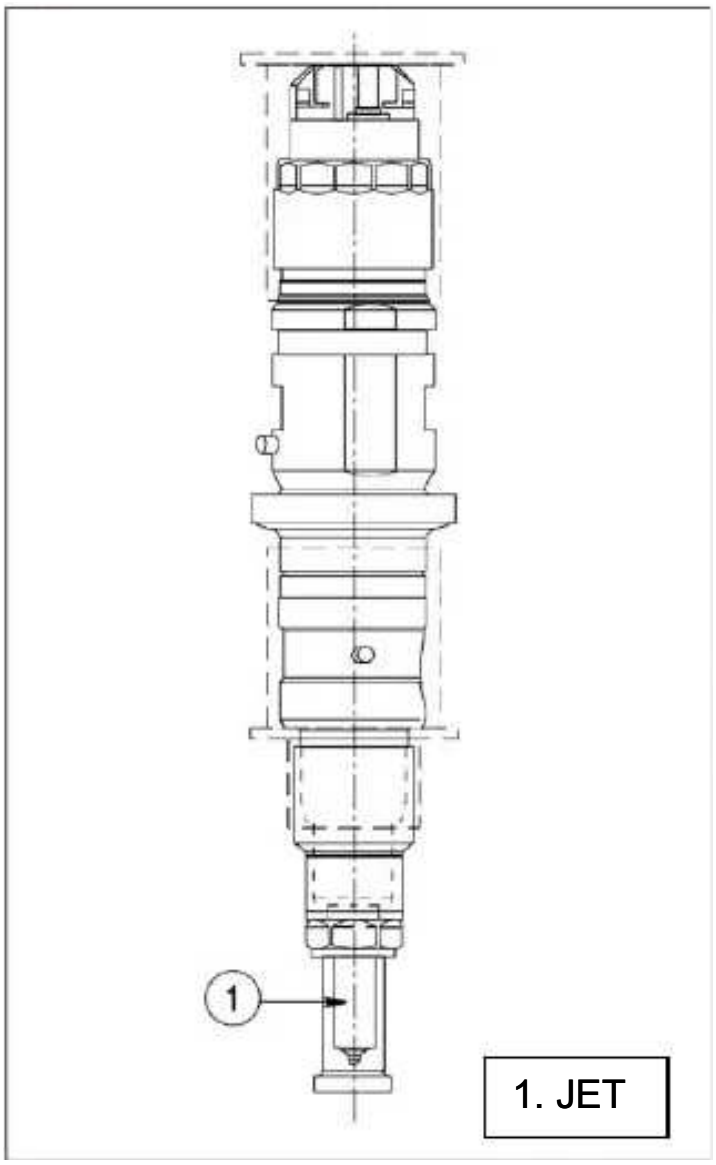
1. Pressure rod	5. Pilot valve	9. Control volume
2. Needle plunger	6. Ball Shutter	10. Supply control line
3. Nozzle	7. Control area	11. Control fuel outlet
4. Coil	8. Pressure chamber	12. Electrical connection
Note: the injector can not be overhauled		

Injection end

When coil (4) is de-energized, the ball shutter (6) returns to its closed position to restore a balance of forces such as to cause the needle (2) to return to its closed position and terminate the injection cycle.

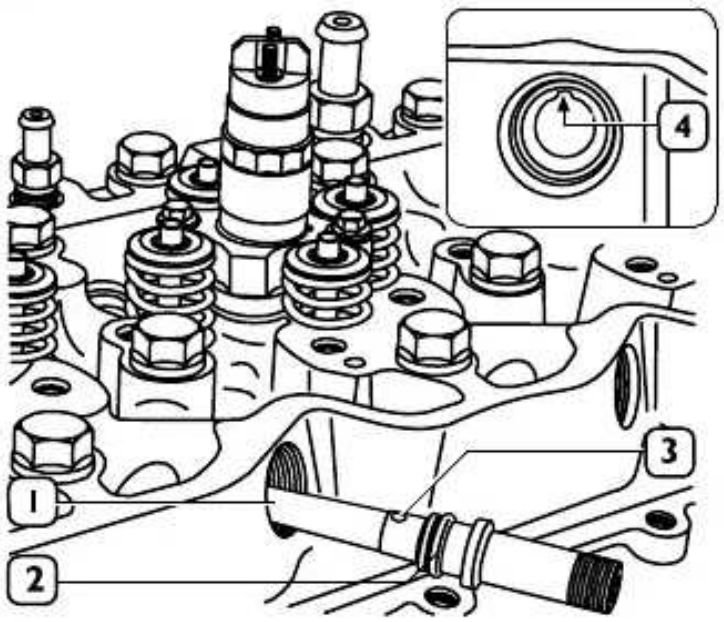
terminate the injection cycle.

The NEF Tier III engines use Bosch CRIN 2 electro-injectors. The injection jets used are according to power developed by the engine.



Injectors	Jet	Power developed	Pressures	
		kW / H.P.	Minimal operating pressure	Nominal operating pressure
CRIN 2	DLLA	Above 152kW (204 h.p.)	250 bar (3626 psi.)	1600 bar (23206 psi.)
CRIN 2	DSLA	Below 152kW (204 h.p.)	250 bar (3626 psi.)	1450 bar (21030 psi.)

Fuel High Pressure Connector



1. Fuel high pressure connector	3. Locating ball
2. O-rings	4. Locating ball seat on cylinder head.

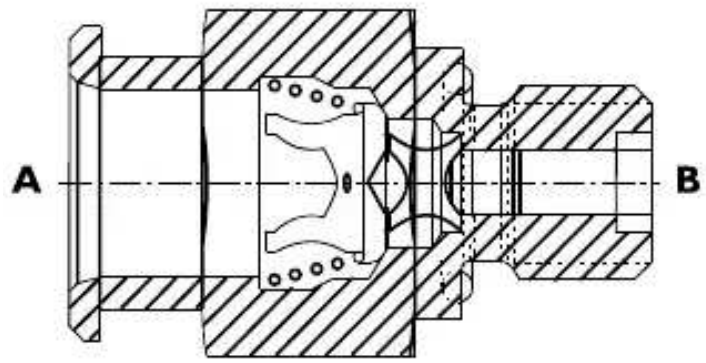
The fuel high pressure connector must be replaced each time it is disassembled. During reassembly, lubricate O-ring (2) with Vaseline and install the fuel high pressure connector (1) onto the head, ensuring that the locating ball (3) is aligned with the corresponding seat (4) in the head.

Note: The injector and fuel high pressure connector must be first installed in the head and alternately tightened to the prescribed torque.

Fuel Return Pressure Regulator Valve

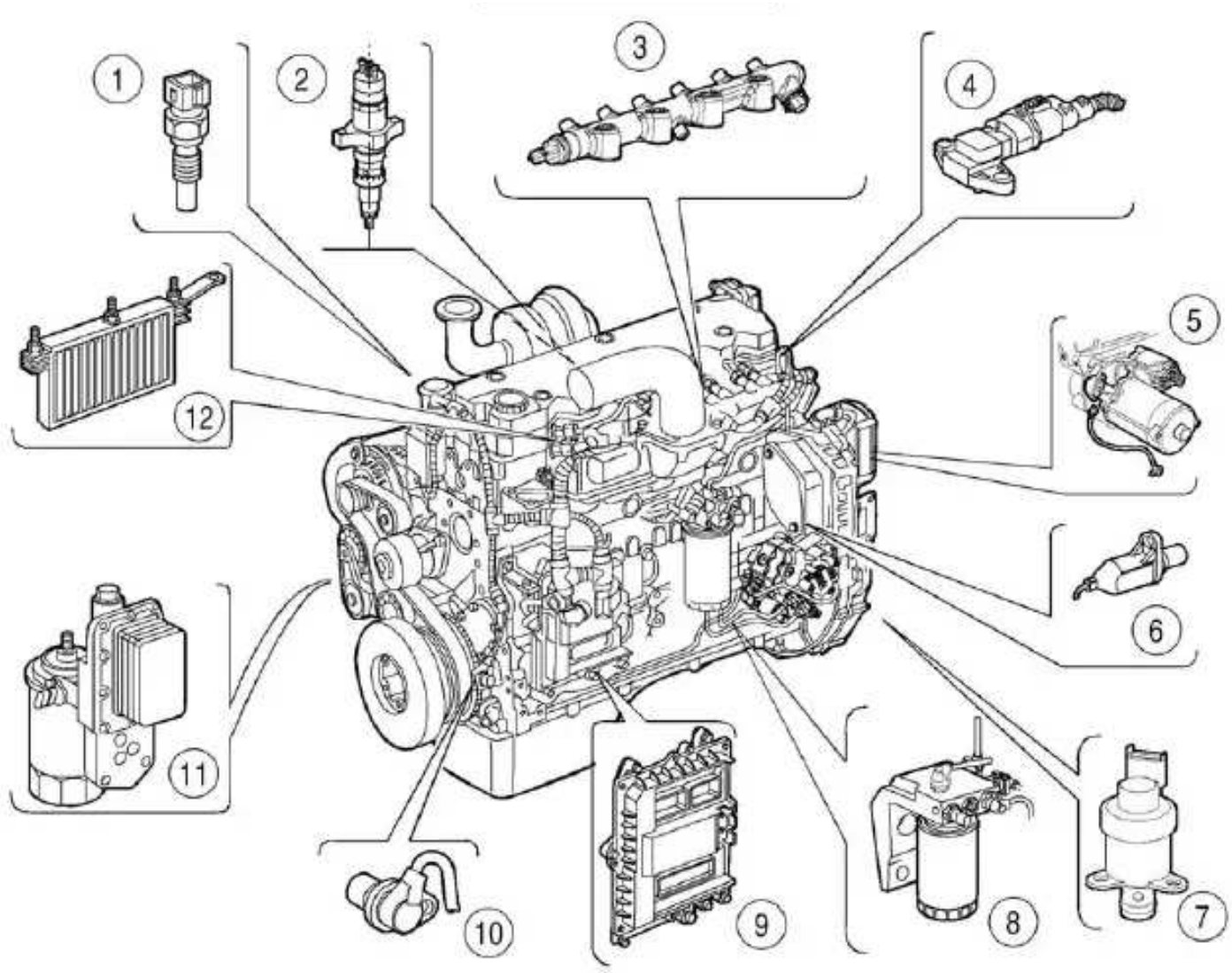
The fuel return pressure regulator valve is installed at the rear of the cylinder head, regulates the pressure of drain fuel returning from the injectors to a pressure of between 1.3 and 2 bar (19 ÷ 29 psi). By guaranteeing this pressure to the return fuel, fuel vapor formation inside injectors is avoided, optimizing fuel spraying and combustion.

Important: use a proper torque wrench with a Crow's Foot to torque the fuel return pressure regulator valve.



A. To tank	B. From electro-injectors

EDC7UC31 System Main Electrical and Electronic Components



Location

Ref.	Description
1	Coolant temperature sensor
2	Electro-injector
3	Common Rail pressure sensor
4	Boost pressure/temperature sensor
5	Starter motor
6	Camshaft timing sensor
7	High pressure regulator solenoid valve
8	Fuel temperature sensor
9	EDC7UC31 electronic control unit
10	Crankshaft speed and timing sensor
11	Engine oil level transmitter (*) – optional by application
12	Engine oil pressure/temperature sensor
13	Intake air pre-post start heater grid

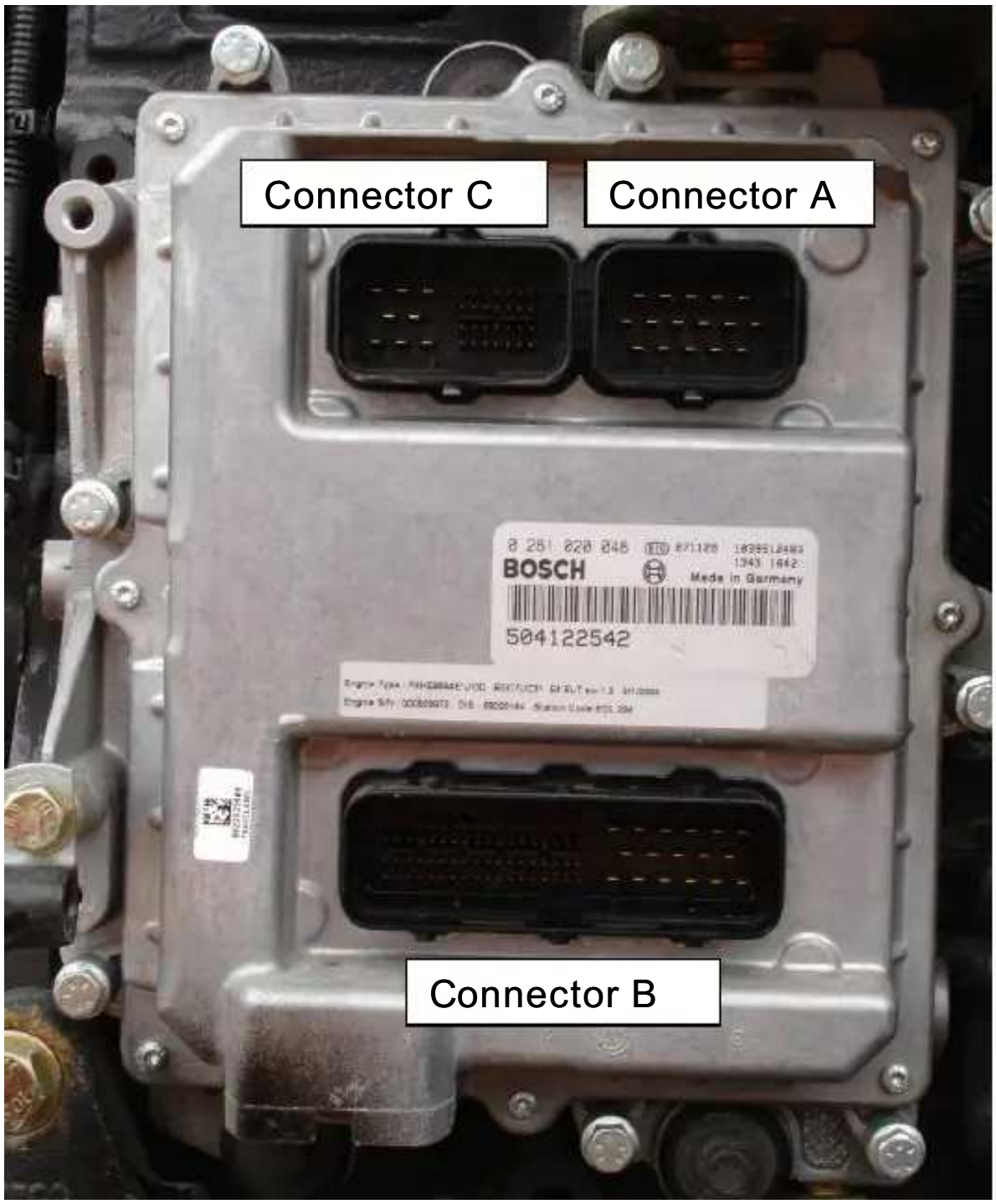
(*) Depending on the application

EDC7UC31 Electronic Engine Control Unit

The engine is fully controlled by the electronic engine control module, which is assembled directly to the engine. It has a heat exchanger base for cooling as well as rubber buffers to reduce vibrations from the engine.

Note: the EDC7UC31 engine control unit is for Tier 3 engines and EDC7 engine control unit (not shown) is for Tier 2 engines. The connectors are similar;

however, they have different wiring. Swapping a Tier 2 controller for a Tier 3 Controller will cause controller damage.

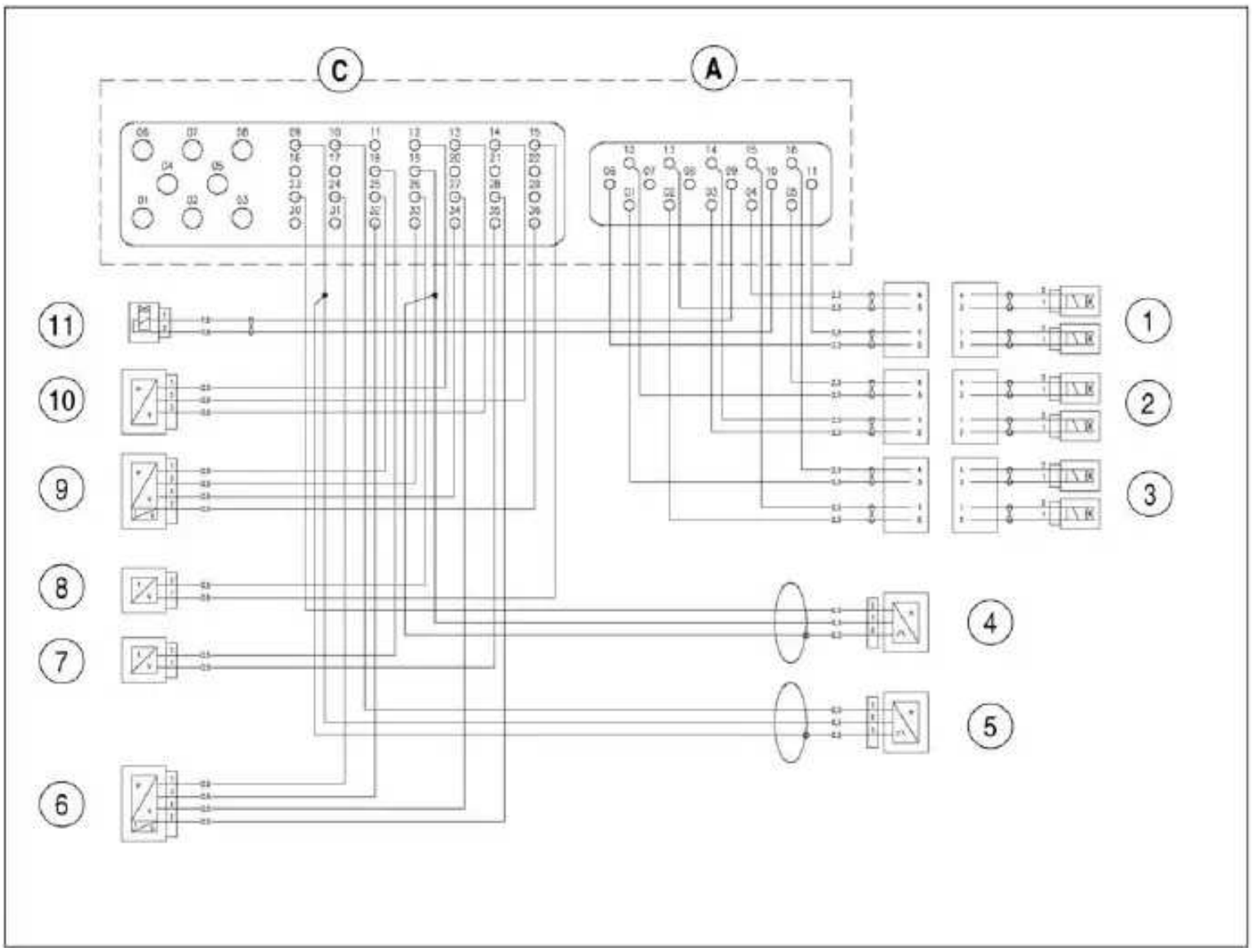


A. Injectors connector

B. Connector for power input and functions provided for in the application

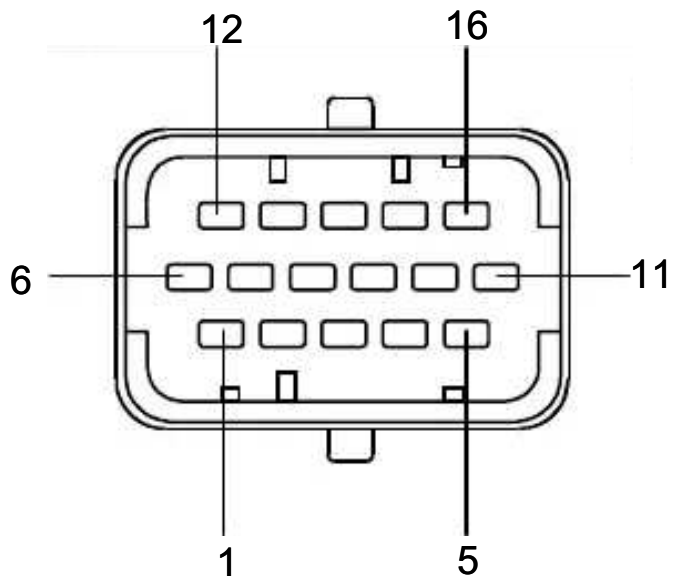
C. Sensors connector

Connector Pin Out



A. Connector A (Injectors) EDC7UC31 ECU (Power)	5. Camshaft Speed Sensor
B. Connector B (Not shown See not Below)	6. Oil Pressure and Temperature Sensor
C (Sensors) EDC7UC31 ECU (Signal)	7. Fuel Temperature Sensor
1. Injectors for Cylinders 1-2	8. Coolant Temperature Sensor
2. Injectors for Cylinders 3-4	9. Boost Air Temperature and pressure Sensor
3. Injectors for Cylinders 5-6	10. Common Rail Pressure Sensor
4. Crankshaft Speed Sensor	11. High Pressure Fuel Regulator Sensor
NOTE: Connector B is not shown because it is specific to the machine application see the particular machine Schematic	

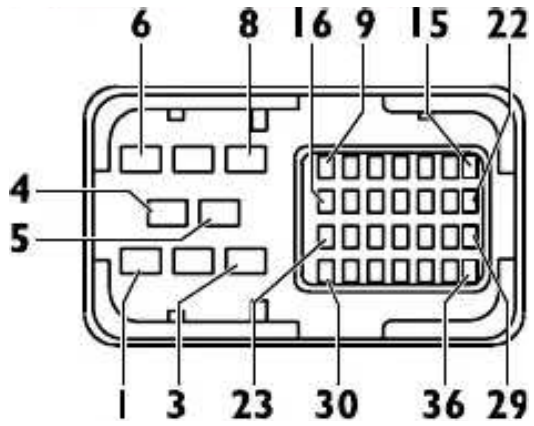
Connector (A) - Injectors



Wire input side view

EDC7UC31 ECU PIN	WIRE COLOR	FUNCTION
1		Cylinder 5 injector
2		Cylinder 6 injector
3		Cylinder 4 injector
4		Cylinder 1 injector
5		Cylinder 3 injector
6		Cylinder 2 injector
7		Not Used
8		Not Used
9		High pressure regulator with fuel metering
10		High pressure regulator with fuel metering
11		Cylinder 2 injector
12		Cylinder 3 injector
13		Cylinder 1 injector
14		Cylinder 4 injector
15		Cylinder 6 injector
16		Cylinder 5 injector

Sensors connector (C)



EDC7UC31 ECU PIN	WIRE COLOR	FUNCTION
9.		Camshaft speed sensor - Signal
10.		Camshaft speed sensor - Ground
12.		Common rail temperature and pressure sensor - Ground
13.		Common rail temperature and pressure sensor - Positive 5 Volts
14.		Common rail temperature and pressure sensor - Signal
15.		Coolant temperature sensor - Signal
18.		Fuel temperature sensor - Signal
19.		Crankshaft speed sensor - Ground
23.		Crankshaft speed sensor - Signal
24.		Engine oil pressure and temperature sensor - Ground
25.		Boost pressure intake pressure sensor - Ground
26.		Coolant temperature sensor - Ground
27.		Engine oil pressure sensor - Signal
28.		Engine oil temperature sensor- Signal
32.		Engine oil pressure and temperature sensor - Positive 5 Volts
33.		Boost intake pressure sensor - Positive
34.		Boost intake pressure sensor - Signal
35.		Fuel temperature sensor - Signal
36.		Boost intake temperature sensor - Signal

EDC7UC31 Engine Electronic Control Parameters

Engine pre-heating and post-heating element control

Pre-post heating is activated when even just one of the water, air or fuel temperature sensors detects a temperature < = 5 °C / 41 °F.

Phase recognition / Rotation position for timing

Camshaft and crankshaft sensors provide crank position and rpm information so that injection timing and duration can be controlled.

Injection control

Based upon information transmitted by the sensors, the electronic control unit controls the common rail fuel pressure, activates the injectors to control the beginning of injection and the amount of fuel injected to each cylinder. On Family 3 and 4 engines, at all engine speeds, a small amount of fuel is pre-injected at about 25 degrees before top dead center (BTDC) while the main injection happens closer to top dead center.

Injection pressure closed loop control

Based upon the engine load, as determined by processing of data transmitted by the various sensors, the engine control unit controls the high pressure fuel regulator to maintain injection pressure at constantly optimal values.

Pilot and main injection advance control

On the basis of signals transmitted by the various sensors, the control unit determines the optimum injection point on the basis of internal mapping.

Idle speed control

The control unit processes signals transmitted by the various sensors and adjusts the quantity of fuel injected. It also controls the high pressure regulator and modulates injection duration of the electro-injectors.
Within specific limits, the control unit also monitors battery voltage.

Overheating protection

If the water temperature reaches 110 °C (230°F), the control unit reduces engine performance.
When the temperature returns below 100 °C (212°F), the engine resumes normal operation.

Maximum engine speed limiting

Depending on the application, the control unit memory can contain appropriate engine speed limits. When the engine speed surpasses these limits the control unit activates power reduction strategies by controlling activation time of the electro-injectors. In some applications the maximum limiting response consists in stopping the engine.

Cut Off

Fuel cut-off in release phases is managed by the EDC7UC31 with the following logical interventions:
- deactivation of the electro-injectors

- reactivation of electro-injectors immediately prior to arrival at idle speed
- control of fuel pressure regulator.

Smoke control under acceleration

With high load demands, in accordance with signals received from the Intake Air temperature pressure sensor and the crankshaft sensor, the control unit manages the high pressure regulator and controls the activation time of the electro-injectors to prevent the emission of smoke from the exhaust.

After Run

After the engine is stopped, the control unit microprocessor remains powered to save various parameters to the EEPROM memory, including the faults log so they will be available the next time the engine is started. Because of this, do not disconnect power before turning the key switch off.

Control of working speed in normal operating conditions

The controller can establish engine working speed (power – torque) according to load (heavy or light) and the system maintaining the engine at these values as load varies. The engine always operates with maximum power while the hydraulic power required during use is managed by varying the speed of the hydraulic fluid and not its pressure. Each time work load varies, the control unit adjusts torque so as to maintain the engine in maximum power conditions. If the load causes a reduction in power, the control unit increases torque i.e. it increases the amount of fuel injected in order to restore the engine to maximum power. If, after setting working speed, the operator does not invoke any command within a pre-set time, the system returns to idling.

Limp Home Recovery Strategies

Recovery strategies are characterized by certain differences as application varies, i.e. loaders or excavators.

- Accelerator pedal (in some applications) When the accelerator signal is not available to the control unit for the excavators, it brings the engine to maximum power because its movement is hydraulic and the vehicle can therefore be controlled in complete safety. In the case of loaders, the system responds by setting engine speed to a predetermined speed, approximately ¾ throttle, to allow the unit to be moved to a repair location.

- Control of fuel leaks In the case of fuel supply problems, the system controls the engine with suitable constant power values obtained with a low engine speed and high torque values in order to inject the maximum quantity of fuel.

- Control of pressure in the rail When the pressure in the common rail exceeds safety values, the rail pressure safety relief valve opens to limit the pressure to a constant pressure and the engine reduces power.

- Synchronism problems In the case of synchronism problems i.e. faulty speed sensors, the system controls the engine by increasing the engine speed to improve interpretation of the signals.
- Power restrictions as intake air temperature increases When the temperature of the intake air rises above 88°C (190°F), power reduction is started. When a temperature of 120°C (248°F) is reached, performance is further reduced and is comparable to that of the same engine if it were not turbocharged.

- Reduction of power as engine oil reference temperature increases In normal operating conditions, the system monitors the supercharging air, engine oil and coolant temperatures. If the temperature of the engine coolant is not available, the system takes the temperature of the engine oil as reference and when this reaches the threshold of 103°C (217°F), it starts to reduce the power available.

  On reaching 113°C (235°F), power is reduced to 50%.

Engine Degradation in CNH Applications - NEF Tier 2 (Example)

Cause of Torque Loss	Conditions	Engine Reaction	CAN Message Information	Flight Recorder Storage	ECM Diagnostic Lamp	Failure Memory Storage
Torque reduction due to overheat protection	Applied: T water > T1= 106 °C T2= 112 °C T intake air > T1= 88°C T2= 120°C	Torque reduction <T1: no reduction >T1, <T2: 0-50% linear reduction >T2: 50% reduction	EDC2BC – Engine Over Temperature	Yes	No	No
Torque reduction at high altitude	Not applied	Not applied	No	No	No	No
Torque reduction due to CAN failure	CAN Bus off or timeout on TSC1 CAN messages	Torque reduction 10%	DM1, Engine Configuration (if readable)	No	ON	Yes
Torque reduction due to system degradation	See BELOW	Torque reduction 10% to 50%	DM1, Engine Configuration	No	BLINK	Yes
Reduction at low temperature after start	Applied	Slight reduction of high idle speed	No	No	No	No
Reduction due to system degradation	See BELOW	Reduction of high idle speed 20% to 30%	DM1, Engine Configuration	No	ON or BLINK	Yes

Degradation Conditions

Conditions for Fuel Quantity Limitation (Torque Reduction):

1. Engine speed sensors defective (torque reduction about 50%)
2. Fuel pressure sensor (torque reduction about 10%)
3. Fuel pressure monitoring-first step (torque reduction about 10%)
4. Fuel pressure power stage actuator (torque reduction about 10%)
5. Monitoring of rail pressure relief valve (torque reduction about 10%)

Conditions for Max Engine Speed Limitation:

1. Fuel pressure monitoring-first step
2. Fuel pressure power stage actuator
3. Monitoring of rail pressure relief valve
4. Fuel pressure sensor

Conditions for Engine Stop:

1. Fuel pressure monitoring-second step

Engine Degradation in CNH Applications - NEF Tier 3 (Example)

Cause of Torque Loss	Conditions	Engine Reaction	CAN Message Information	Flight Recorder Storage	ECM Diagnostic Lamp	Failure Memory Storage
Torque reduction due to overheat protection	Applied: T water > T1= 106 °C T2= 112 °C T intake air > T1= 88°C T2= 120°C	Torque reduction <T1: no reduction >T1, <T2: 0-50% linear reduction >T2: 50% reduction	EDC2BC – Engine Over Temperature	Yes	No	No
Torque reduction at high altitude	Not applied	Not applied	No	No	No	No
Torque reduction due to CAN failure	CAN Bus off or timeout on TSC1 CAN messages	Torque reduction 0 %..25%..50%, according to different applications	DM1, Engine Configuration (if readable)	No	ON	Yes
Torque reduction due to system degradation	See BELOW	Torque reduction 15% to 40%	DM1, Engine Configuration	No	ON or BLINK	Yes
Reduction at low temperature after start	Applied	Reduction of high idle speed T > -15°C: no reduction T < -15°C, > -20°C: linear reduction T < -20°C: 20%..30% reduction	No	No	No	No
Reduction due to system degradation	See BELOW	Reduction of high idle speed 20% to 30%	DM1,Engine Configuration	No	BLINK	Yes

Conditions for Fuel Quantity Limitation (Torque Reduction):

1. Ambient pressure sensor defective (torque reduction about 15 %)
2. Engine speed sensors defective (torque reduction about 15 %)
3. Fuel pressure monitoring-first step (torque reduction about 15 %)
4. Fuel pressure power stage actuator (torque reduction about 15 %)
5. Shut off self test failure (torque reduction about 15 %)
6. Sensors power supplies defective (torque reduction 15 % to 40%)
7. Accelerator pedal sensor defective (torque reduction about 15 %)
8. Starter actuator defective (torque reduction about 15 %)

Conditions for Max Engine Speed Limitation:

1. Fuel pressure monitoring-first step
2. Fuel pressure power stage actuator
3. Fuel pressure sensor

Conditions for Engine Stop:

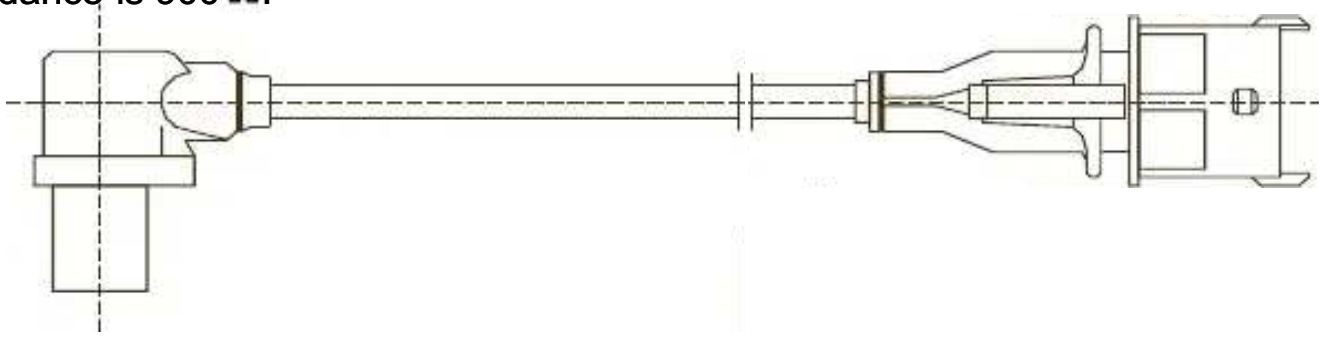
1. Fuel pressure monitoring-second step
2. Monitoring of rail pressure relief valve

2. Monitoring of rail pressure relief valve
3. Internal ECU monitoring defective

SENSORS

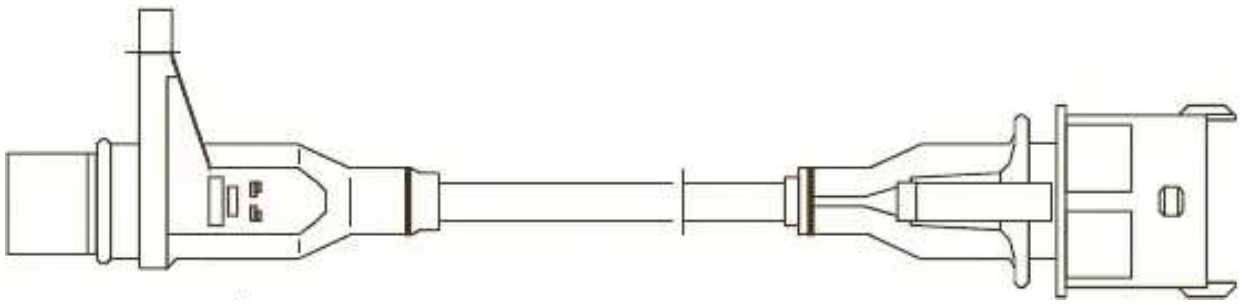
Crankshaft speed/timing sensor

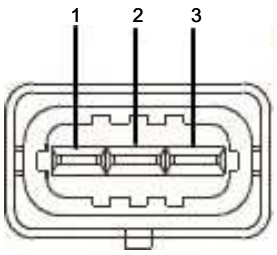
This is an inductive sensor located at the front left hand side of the engine. The crankshaft sensor sends signals to the engine controller as the engine rotates.
The crankshaft sensor is connected to the control unit on pins 19C – 23C. The sensor impedance is 900 Ω.



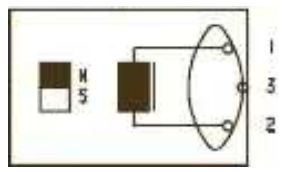
Camshaft speed/timing sensor

This is an inductive sensor located at the rear left hand side of the engine. The camshaft timing sensor sends signals to the engine controller as the engine rotates. The signal is utilized by the electronic control unit to control the injection timing.
Although it is similar to the crankshaft sensor, these two devices are NOT interchangeable because of the different external shape.
The timing sensor is connected to the control unit on pins 9C – 10C. The sensor impedance is ~ 900 Ω.





CONNECTOR C



WIRING DIAGRAM

Ref.	Description	ECU pin	
		Crankshaft sensor	Camshaft sensor
1	Signal	19C	10C
2	Signal	23C	9C

3	Shield		

Boost pressure temperature sensor

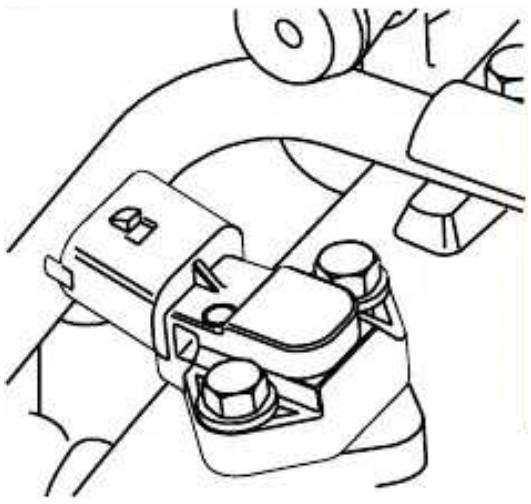
This component incorporates a temperature sensor and a pressure sensor.
Mounted on the intake manifold, the sensor measures the temperature and boost pressure, which serves to make an accurate calculation of the quantity of fuel to be injected in each cycle.
The sensor is connected to the control unit on pins 25C – 33C – 34C – 36C.
The power supply is 5 volt
Voltage at the sensor output is proportional to the detected pressure or temperature.

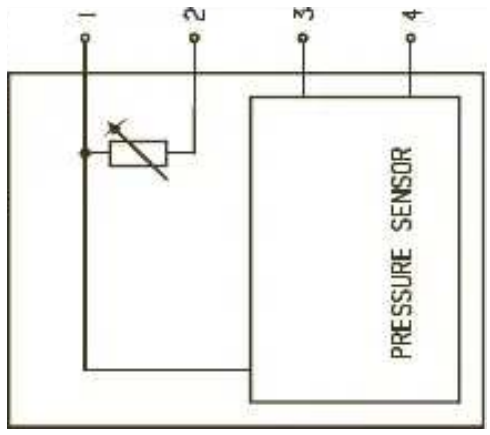
- Pin 25C – 36C Temperature
- Pin 33C – 34C Pressure

Engine oil temperature-pressure sensor

This component is similar to the intake air temperature-pressure sensor.
The engine oil temperature-pressure sensor is installed on the engine oil filter support in a vertical position. This sensor measures the engine oil temperature and pressure.
The sensor is connected to the control unit on pins 24C - 32C - 27C - 28C.
The sensor is supplied with 5 Volts. The pressure signal is transmitted to the EDC control unit which, in turn, sends a signal to the instrument panel (gauge + low pressure warning light).
The oil temperature is not displayed on any gauges – this value is used exclusively by the control unit.

- Pin 24C – 28C Temperature
- Pin 32C – 27C Pressure





WIRING DIAGRAM

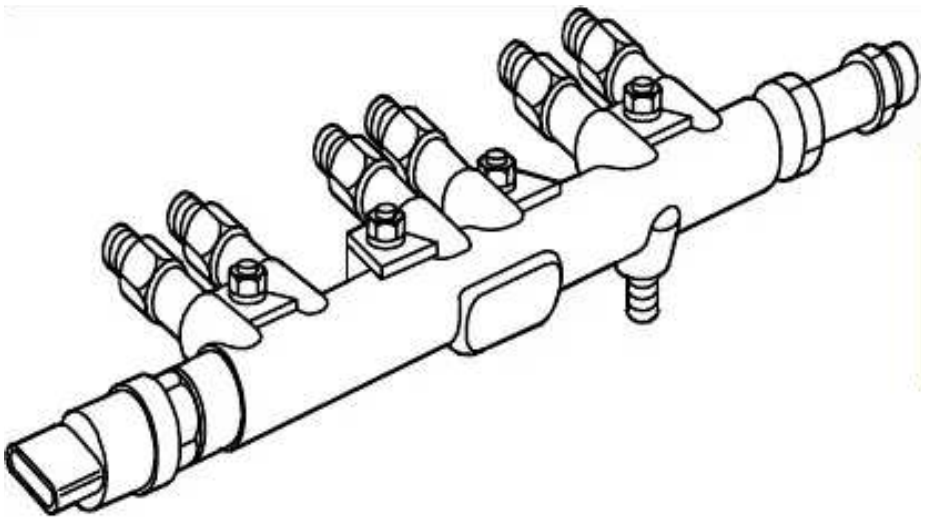
REF.	DESCRIPTION	ECU PIN	
		OIL	AIR
1	Ground	24C	25C
2	NTC signal (temperature)	28C	36C
3	+5 V power input	32C	34C
4	Signal (pressure)	27C	34C

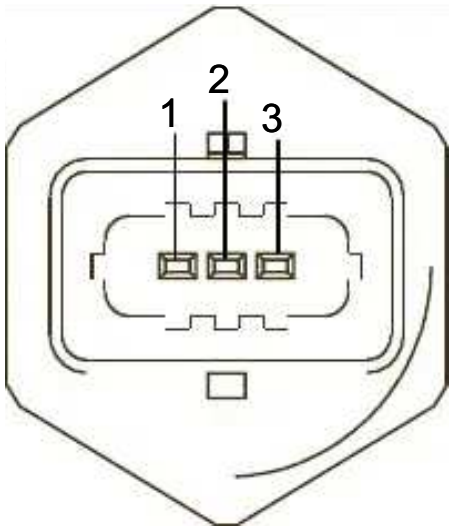
Common rail fuel high pressure sensor

Mounted on one end of the common rail, this sensor measures the internal fuel pressure and informs the control unit of the value (feedback).
The injection pressure value is used by the controller to regulate the high pressure output flow from the pump and to determine the duration of the electrical injection command.

This sensor is connected to the control unit on pins 12C – 13C– 14C.

The power supply is 5 Volt.





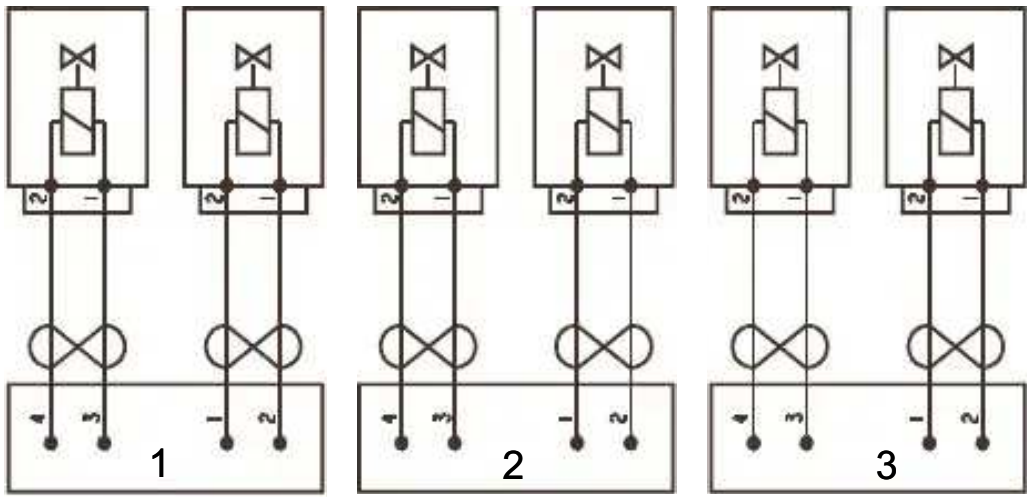
Fuel pressure sensor connector

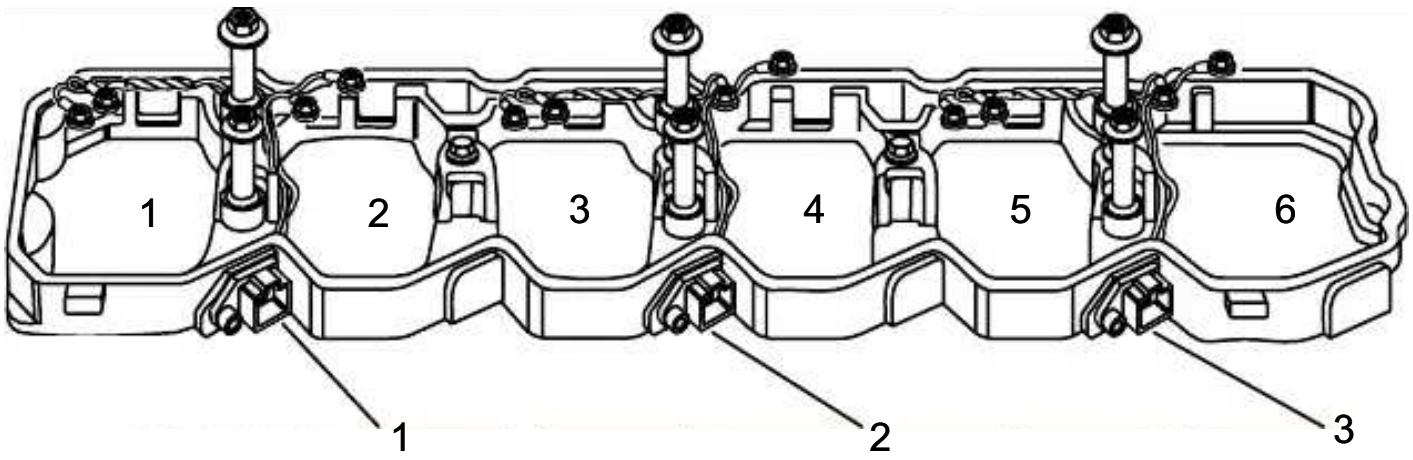
Ref.	Description	ECU pin
1	Ground	12C
2	Signal	14C
3	Power supply	31C

Electro-injectors

The electro-injectors are effectively N.C. solenoid valves.
Each injector is connected to the EDC control unit on connector A.
The resistance impedance of the coil of each injector is 0.56 - 0.57 Ω.

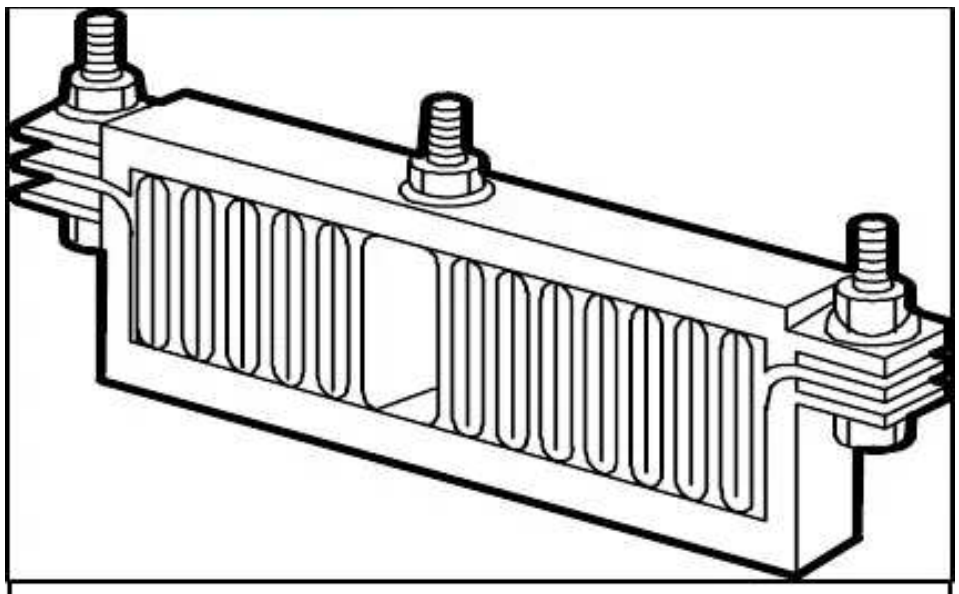
.		Description	ECU pin
CONNECTOR 1	1	Cylinder 2 injector	6 A
	2	Cylinder 2 injector	11 A
	3	Cylinder 1 injector	4 A
	4	Cylinder 1 injector	13 A
CONNECTOR 2	1	Cylinder 4 injector	3 A
	2	Cylinder 4 injector	14 A
	3	Cylinder 3 injector	5 A
	4	Cylinder 3 injector	12 A
CONNECTOR 3	1	Cylinder 6 injector	2 A
	2	Cylinder 6 injector	15 A
	3	Cylinder 5 injector	1 A
	4	Cylinder 5 injector	16 A



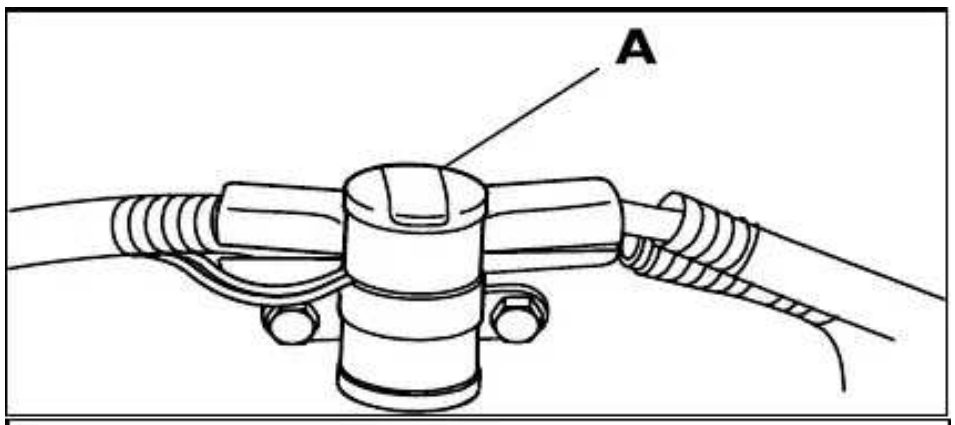


Intake air pre-post heater grid plate and relay

The intake air pre-post heater grid plate is located on the intake manifold.
The grid plate serves to heat the air in pre / post starting operations. This grid plate is powered by a relay on the left hand side of the chassis.
The grid plate resistance impedance is approximately 0.5 Ω.



GRID HEATER PLATE



A. CONTROL RELAY

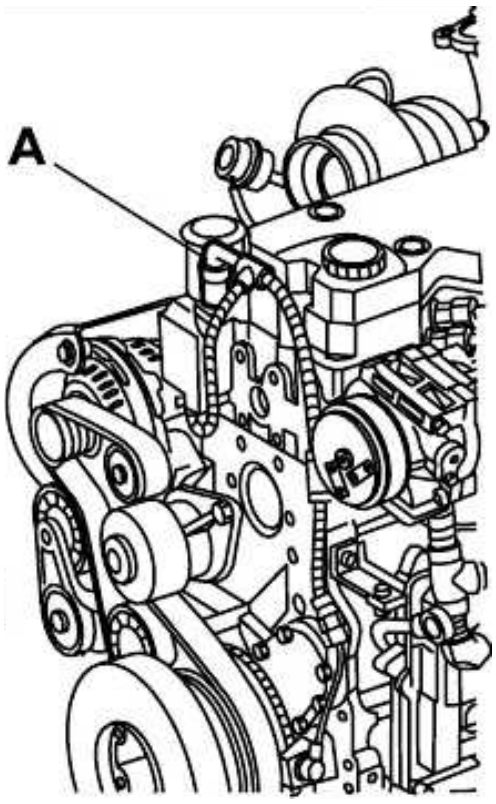
The control relay is connected to the control unit on pins 12B – 75B.
The relay is tripped when either the water and/or fuel temperature is below 5 °C (41°F).
The relay resistance impedance is approximately 15 Ω.

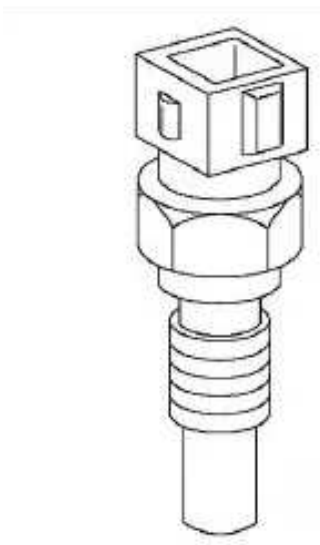
Coolant temperature sensor

This coolant temperature sensor is a variable resistance sensor able to read the coolant temperature and send this information to the control unit.
The same signal is used by the control unit to drive an instrument panel gauge, if present.

This sensor is connected to the control unit on pins 15C – 26C.

The resistance of the coolant temperature sensor at 20 °C (68°F) is approximately 2.50 kΩ.





Coolant Temperature Sensor

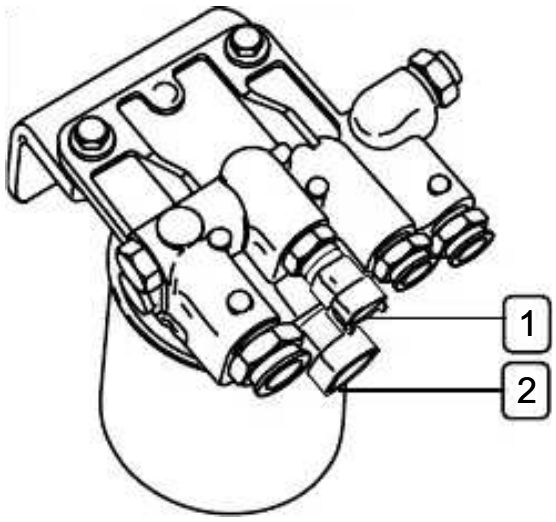
REF.	DESCRIPTION	ECU PIN
		COOLANT
1	Ground	15C
2	Temperature signal	26C

Fuel temperature sensor

This sensor is identical to the coolant temperature sensor.
This sensor measures the fuel temperature so that the controller can precisely inject fuel required.

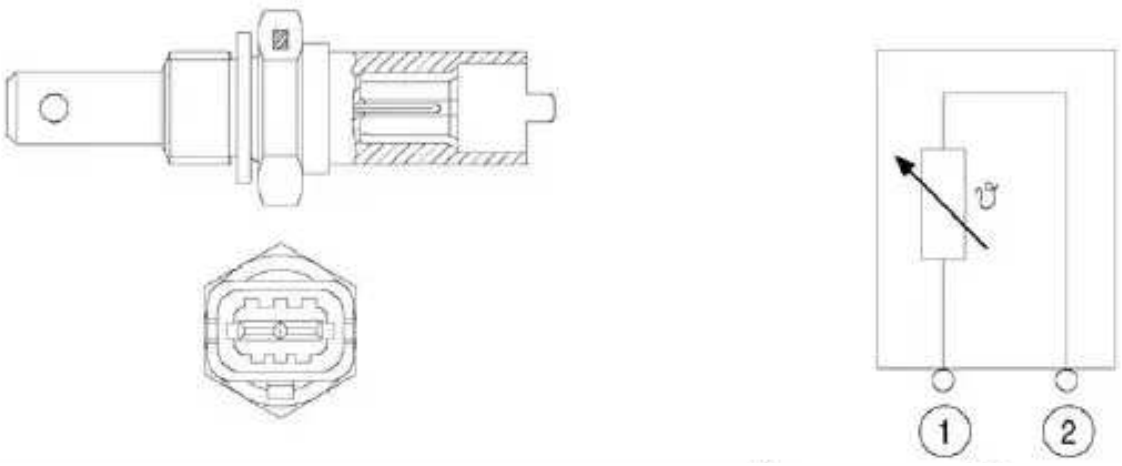
The fuel temperature sensor is connected to the control unit on pins 35C – 18C.

The sensor resistance impedance at 20 °C (68 °F) is approximately 2.50 kΩ



1. Fuel temperature sensor	2. Filter heater

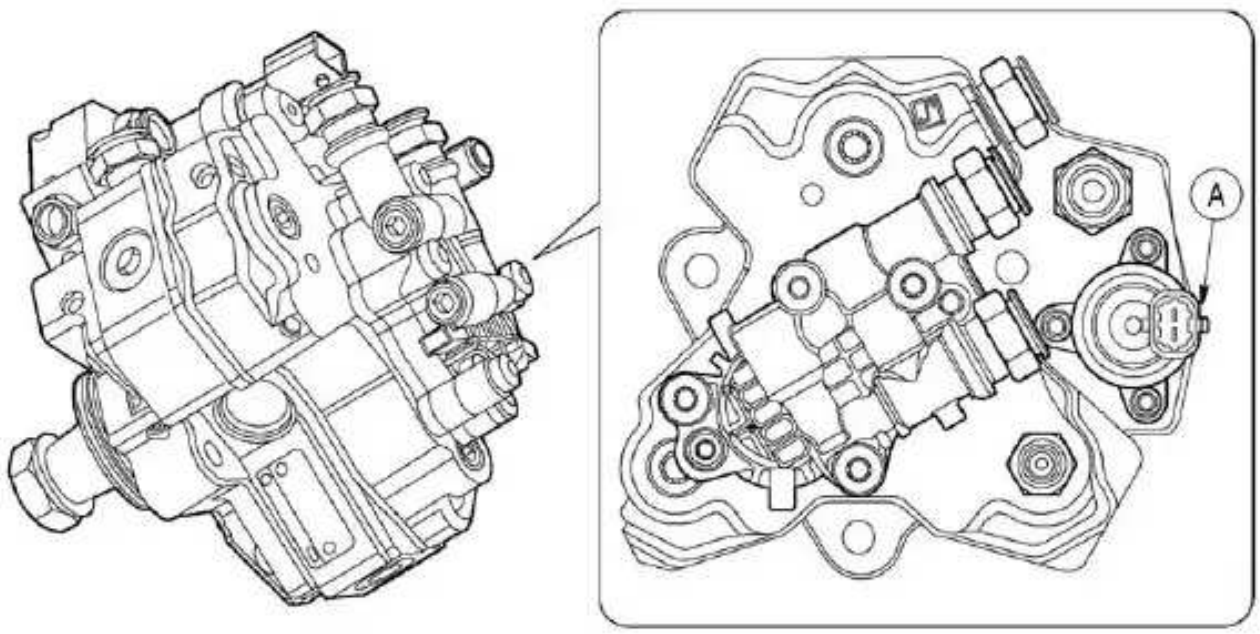
The ECU activates the filter heater relay at fuel temperature ≤ 5 °C (41°F).



Fuel Temp Sensor Connector

REF.	DESCRIPTION	ECU PIN
		FUEL
1	Ground	35C
2	Temperature signal	18C

High Pressure Pump – Pressure Regulator Solenoid Valve



A. High pressure pump pressure regulator solenoid valve

The quantity of fuel supplied to the common rail by the high pressure pump is controlled by the high pressure regulator solenoid valve. The high pressure regulator solenoid is managed by the EDC7UC31 control unit.

Delivery pressure to the rail is regulated between 250 and 1600 bar (3625 and 23200 psi) by the electronic control unit by controlling the pressure regulator solenoid valve.

This high pressure regulator is a N.O. (normally open) solenoid valve.

The solenoid is connected to the control unit on pins 9A – 10A.

The solenoid valve resistance impedance is approximately 3.2 Ω.

Special Tools

380000158..... 1-6 Nm dyanametric (torque) screw driver for calibrating injector solenoid valve connector check nut (Common Rail).

380000665..... Tool for removing the crankshaft front seal.

380000663..... Tool for removing the crankshaft rear seal.

380000671..... Injector extracting tool.

380000666..... Coupler for installing the crankshaft front seal.

380000664..... Coupler for installing the crankshaft rear seal. (except engines: 667TA/EBF - 667TA/EED).

380000988..... Tool for rotating the engine flywheel (except engines 667TA/EBF - 667TA/EED).

380001099..... Tool for removing injectors

CNH- EST DIAGNOSTIC TOOL

BS06K009

Figure 1-1

The EST system allows diagnoses on machines by detecting the operating parameters of electronic control components (control units, sensors etc.) and check flow rates, pressures and temperatures. It is also capable of reading fault codes on the engine. To help with troubleshooting the engine failure mode.

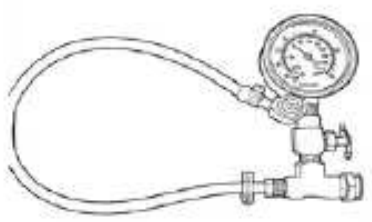
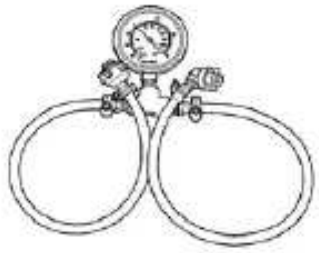
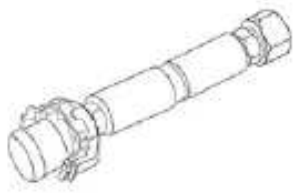
Engines – Tier II Compliant, Common Rail (New Engine Family NEF)

380040185 — Harness Diagnostic/Repair Kit

380040188 — Electro Injector Test Fixture

New Engine Family (NEF) Fuel Supply / Leakage Test Kit – 380140055

380140055 was developed to help diagnose the cause of fuel system inlet air leaks, fuel system flow restrictions, fuel system supply pressure problems and also leakage at the supply tube to the injector interface.

380100056 	**380100057** 	**38014005 Kit Contents:** 380100056 - 0 to 100 kPa/0 to 30" HG, 0 to 200 kPA/0 to 30 PSI Gauge and Clear Hose Assembly **Important:** *DO NOT install this gauge at any location after the gear pump outlet on electronic fuel system engines.*
380100058 	**380100059** 	380100057 - 0 to 11 Bar (0 to 160 PSI) Gauge and Hose Assembly 380100058 - Plastic 2000 ml (4.2 pint) Container 380100059 - External Voss Blocked Connector
380100060 	**380100061** 	**380100062** 
		380100060 - Internal Voss Coupler Cap 380100061 - External Cap Fitting (M14 x 1.5 Tube) 380100062 - Plastic 100 ml (3.4 oz.) Beaker

Note: a number of engine symptoms require the use of this kit.

NEF Engines (Mechanical Fuel System)

The cause of fuel leaks at the advance piston cover on BOSCH VE fuel injection pumps. Fuel leakage at this location can be caused by:

- Fuel Inlet/Return Restriction
- Air Ingress into the Fuel Supply

NEF Engines (Electronic Fuel System)

Diagnose the following fuel system problems on NEF electronically controlled engines:

- Fuel Inlet/Return Restriction
- Air Ingress into the Fuel Supply
- Fuel Delivery Performance of Gear Supply (lift) pump
- Check Pressure Control of the High Pressure Pump Inlet Regulator
- Check Fuel Supply Pressure to the High Pressure Pump
- Check Fuel Leakage Rate from Electronically Controlled Injectors
- Isolate Cause of Excessive Fuel Leakage from Injectors
- Provide an Alternate Fuel Supply to Diagnose Fuel Inlet Problems

New Engine Family (NEF; Family III) – Mechanical Fuel Systems

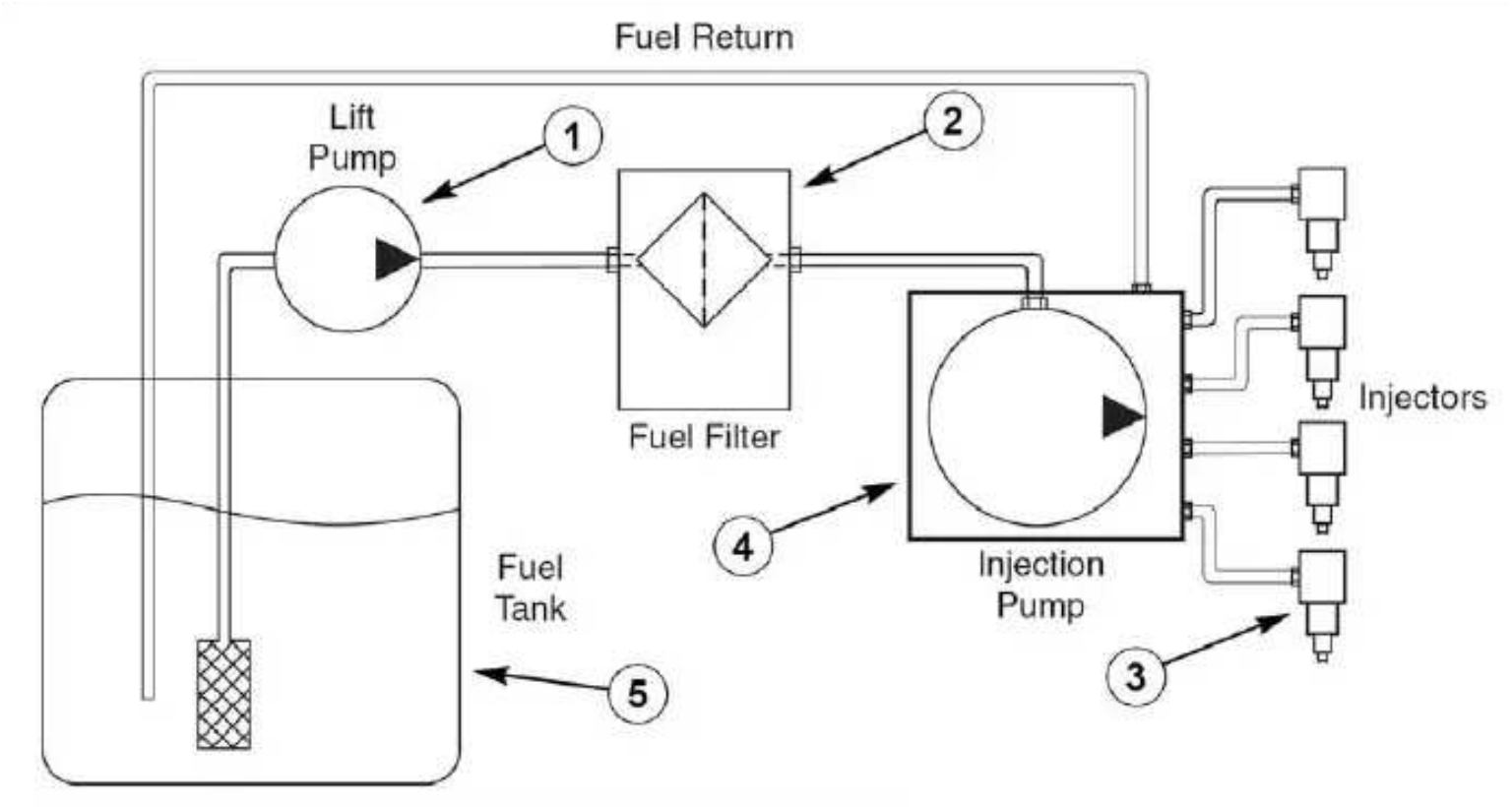
Introduction

Test the fuel system as described before removing the fuel injection pump for repair if possible. If leakage is too severe to test the system before repair, complete the test procedure immediately following the pump repair or replacement. Failure to properly

test the system may result in repeat pump leakage and failure.

Section 1: Mechanical Fuel System Description

The fuel injection system consists of: The fuel supply, a mechanically operated lift pump, a fuel filter, the injection pump, fuel injectors, and the necessary lines and connections.



Item	Description
1	Mechanically Operated Lift Pump - This pump supplies fuel to the fuel injection pump. It is driven by a lobe on the camshaft.
2	Fuel Filter
3	Fuel Injectors
4	Injection Pump
5	Fuel Tank

Section 2: Fuel Leaks at the Advance Piston Cover

BOSCH VE mechanical fuel injection pumps can develop a fuel leak at the advance piston cover. The leak is caused by instability of the advance piston due to:

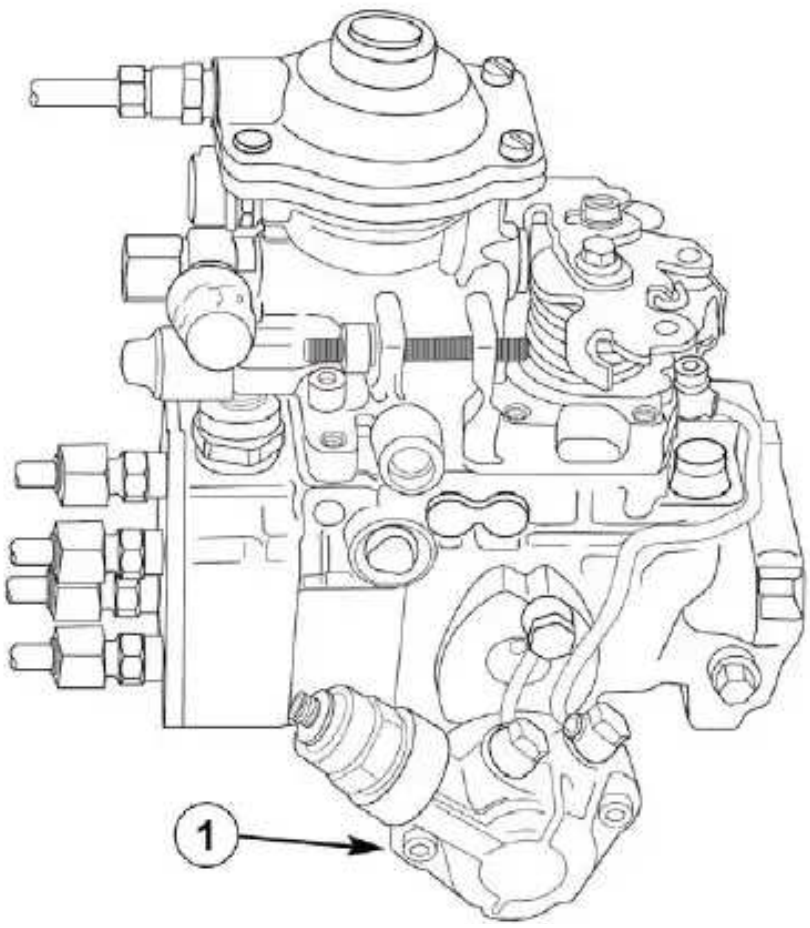
- High Fuel Inlet Restriction
- Air Ingress into the Fuel Supply

The fuel leak typically develops on the back side of the fuel injection pump (between the fuel pump and the engine block.

Important: If possible, test the fuel system as described before removing the BOSCH VE fuel injection pump for repair. If leakage is too severe, complete the test procedure immediately following the pump repair or replacement. Failure to test the system may result in continued pump leakage/failure.

Testing Specifications and Tips

- Vacuum between the inlet of the fuel lift pump and the tank should not exceed 50.8 mm (2 inches) of Hg.
- Fuel supply pressures between the fuel filter and the inlet to the injection pump should be 0.276 to 0.414 bar (4 to 6 psi) with the engine loaded or unloaded.
- Run multiple tests while observing fuel pressure and looking for air in the fuel.
- Perform a "wiggle test" on each fuel line. A steady stream of bubbles or foam should not be seen moving through the fuel system. Very small random bubbles are allowable (reference Section 3 for procedure).



Item	Description

Item	Description
1	Advance Piston Location

Section 3: Fuel Inlet Restriction / Air Entering System

NEF Mechanical Fuel Systems

To determine if the low-pressure fuel supply is restricted, or if air is entering the system.

1. Install 380100056 between the outlet of the fuel filter and the inlet of the BOSCH VE fuel injection Pump.
   - This test line contains a compound gauge – 0 to 762 mm (0 to 30 inches) of Hg Vacuum and 0 to 2.7 bar (0 to 30 psi) positive pressure
   - This test line is constructed of clear tubing to allow observation for air in the system

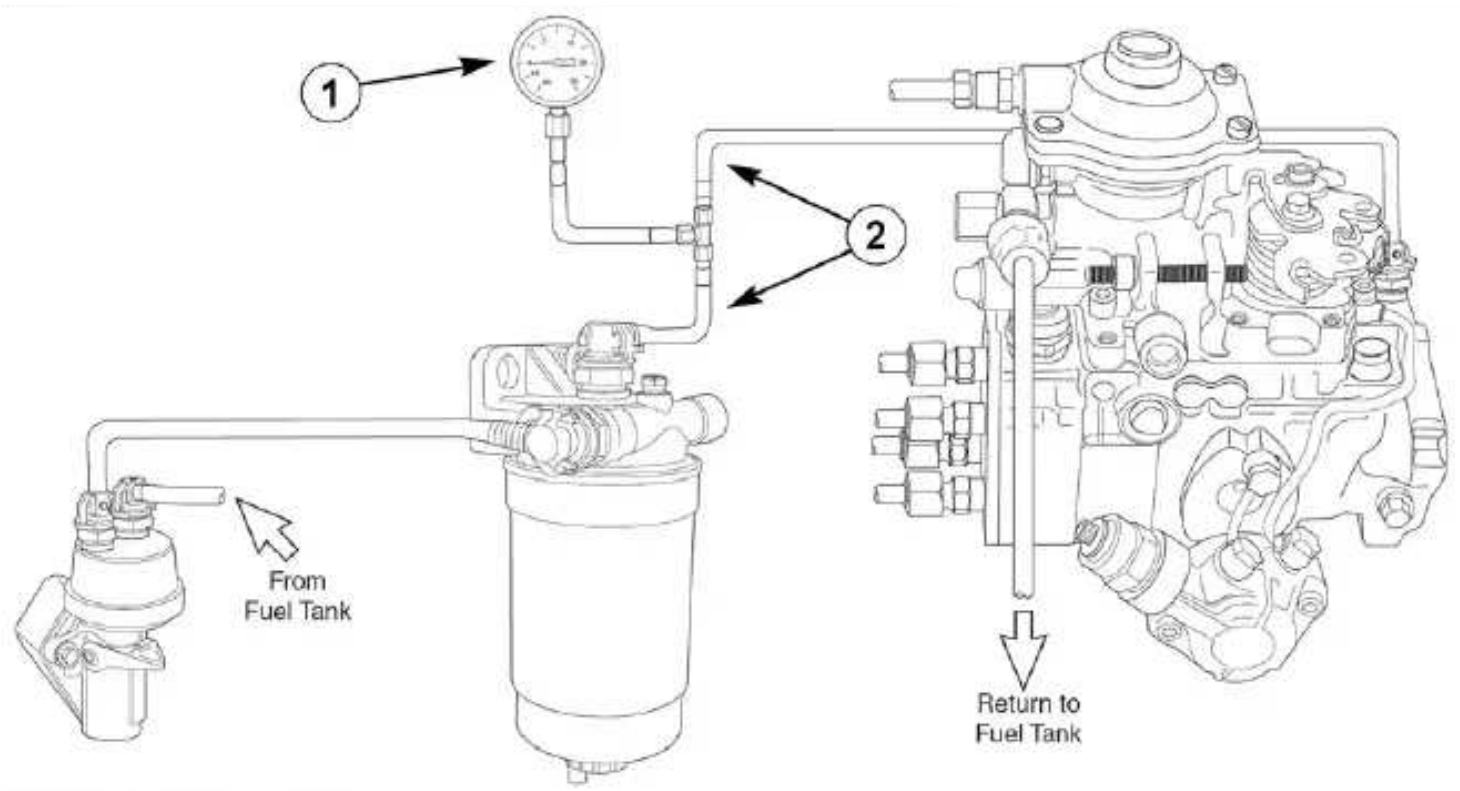
   _____ Operate the engine to purge air from the system which entered during gauge installation

2. When air is no longer visible in the clear test line, measure and record the operating pressure, while continually observing for air in the fuel. Fuel Pressure Specification between Filter and Injection Pump: 0.276 to 0.414 bar (4 to 6 psi). Conditions:

   _____ Pressure at Low idle; apply no load to the engine

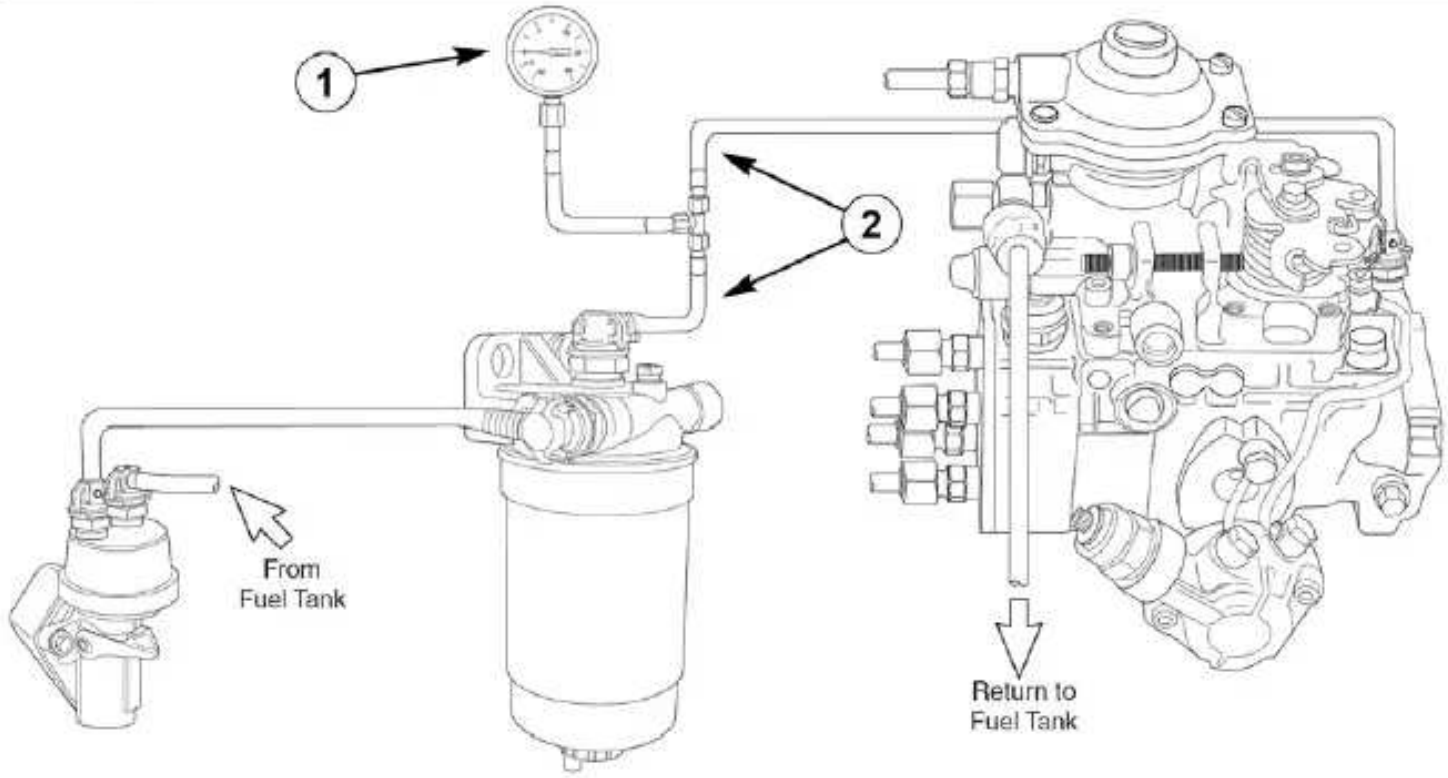
   _____ Pressure at High idle; apply no load to the engine

   _____ Pressure at High idle; apply load to the engine using the hydraulics (over relief), hydrostatic stall, converter stall, or dynamometer. Load the engine to its rated rpm.



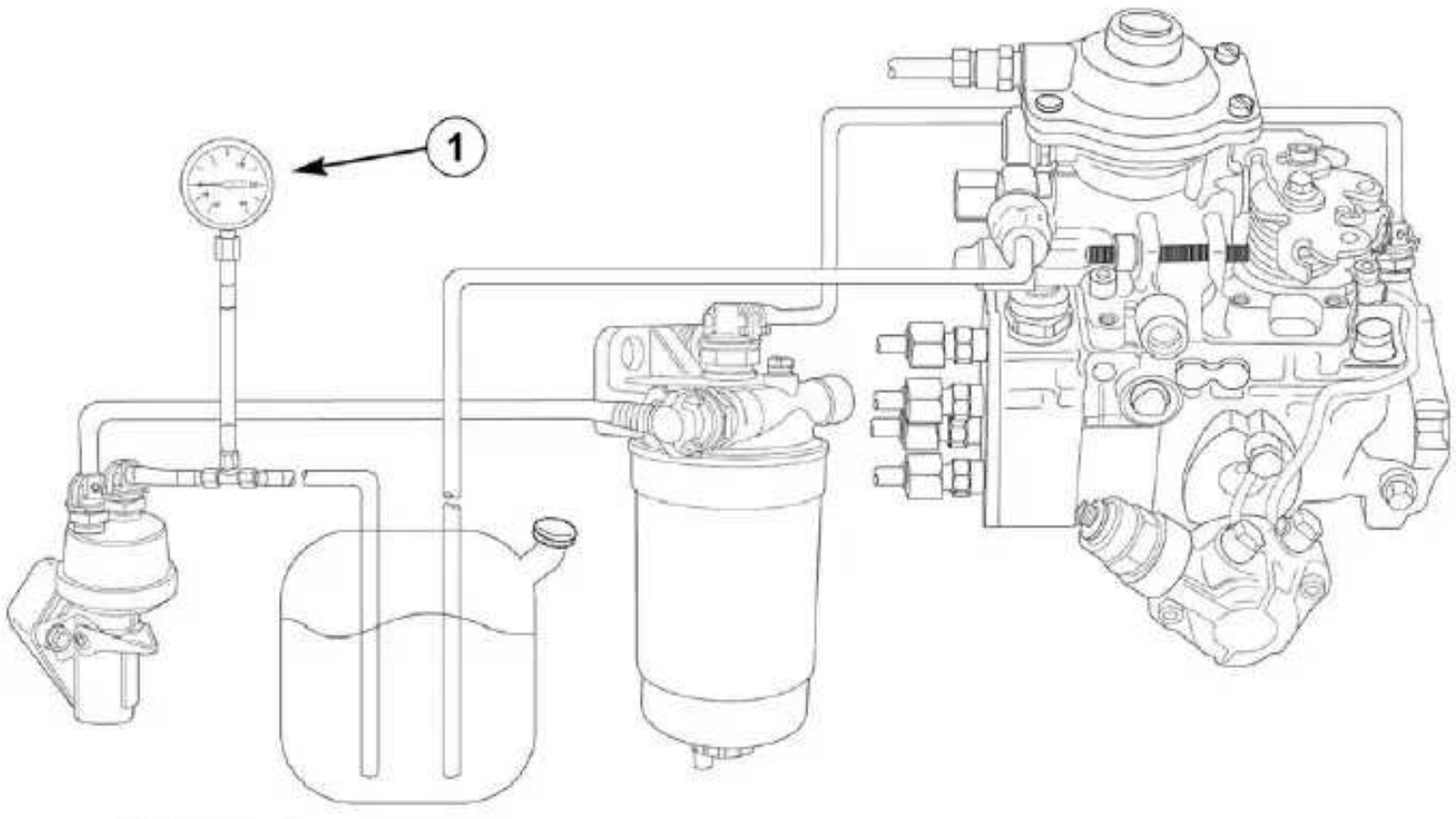
Item	Description
1	380100056 - 0 to 100 kPa/0 to 30" HG, 0 to 200 kPA/0 to 30 PSI Gauge and Clear Hose Assembly
2	Test line constructed with clear tubing to allow observation for air in the system.

3. If the fuel is below 0.276 bar (4 psi) at any time during the tests, check/replace the following as needed:
   - Fuel Pre-filter (if equipped). Some applications do not use a fuel pre-filter.
   - Fuel Filter(s)
   - The lines and connections from the fuel lift pump inlet back to the fuel tank, checking for damaged lines (kinks create restriction; rub marks may allow air to enter) and leakage at the Voss o-ring fittings.
   - Fuel tank, clean as required.
   - The fuel pick-up tube in the fuel tank. Check for cracks, plugging, or contact with the bottom/sidewalls of the tank.
   - Check the valve at the fuel tank outlet (if equipped). Ensure that fuel supplied to and from the valve assembly is properly connected.
   - The fuel tank cap. Be sure a vacuum is not being formed in the fuel tank. A vacuum at the tank would reduce the fuel supply pressure to the injection fuel pump inlet. Vacuum in the fuel tank might not be observable during short-term running.



Item	Description
1	380100056 - 0 to 100 kPa/0 to 30" HG, 0 to 200 kPA/0 to 30 PSI Gauge and Clear Hose Assembly
2	Test line constructed with clear tubing to allow observation for air in the system.

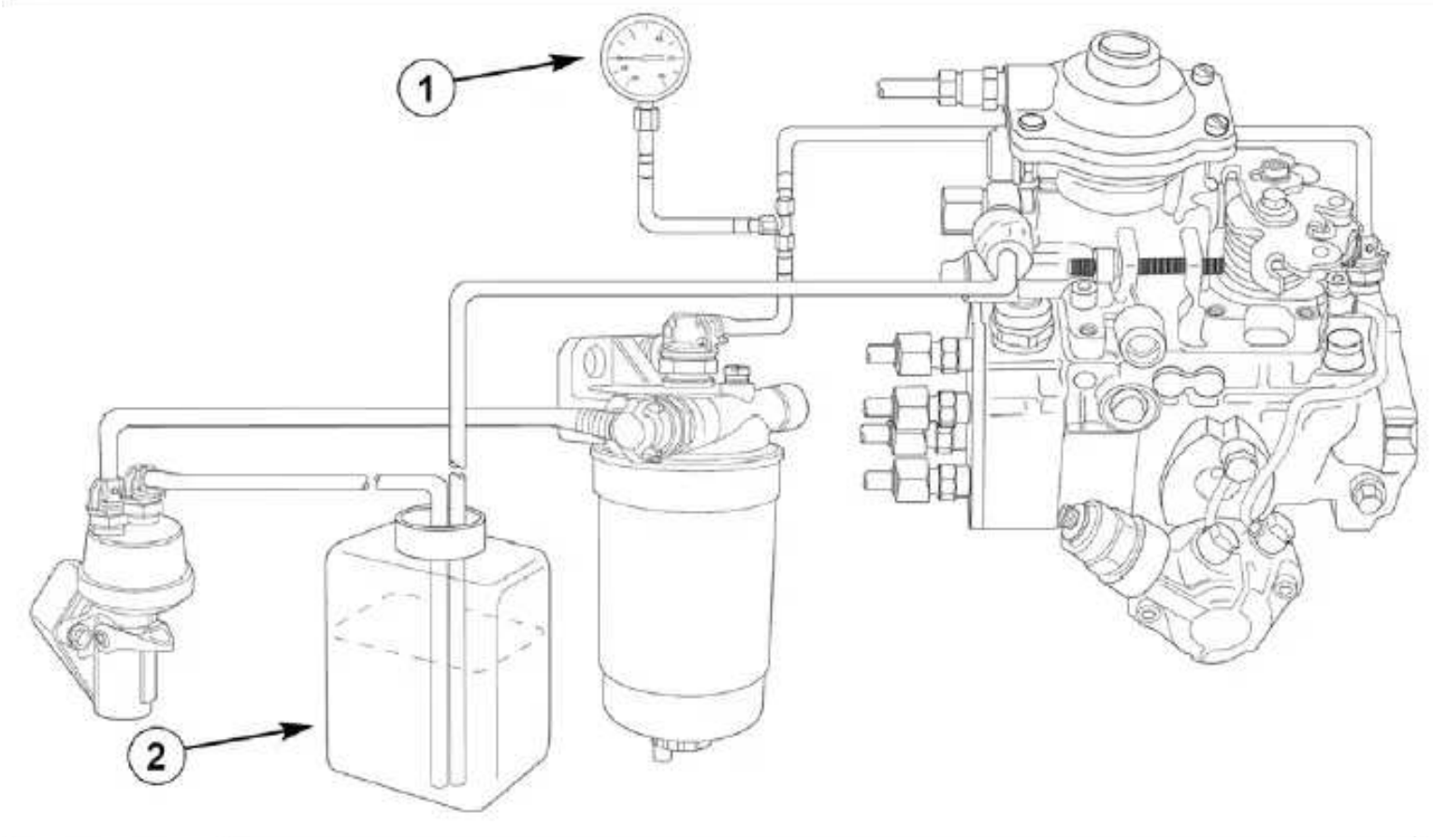
4. If the fuel pressure is below 0.276 bar (4.0 psi) at any time during the tests, install 380100056 between the outlet of the fuel tank and the inlet of the fuel lift pump. Check the following:
   - Continuous air bubbles
   - Vacuum between the inlet of the low pressure pump and the tank should not exceed 50.8 mm (2 inches) of Hg under full load. If vacuum reading exceeds 50.8 mm (2 inches) of Hg, inspect fuels lines for plugging or debris in the fuel tank.



Item	Description
1	380100056 - 0 to 100 kPa/0 to 30" HG, 0 to 200 kPA/0 to 30 PSI Gauge Assembly

5. Supply fuel from an alternate fuel source (a separate container, 380100058), located not more than 1m (3.3 ft.) below the engine with a known good supply line. This bypasses:
   - The Fuel Tank, Inlet Lines and Connections, and Pre-Filter (if equipped)

   Re-run the filter outlet pressure test. If pressures return to normal, check the fuel supply line and the tank of the vehicle for leaks or restrictions.



Item	Description
1	380100056 - 0 to 100 kPa/0 to 30" HG, 0 to 200 kPA/0 to 30 PSI Gauge and Clear Hose Assembly
2	380100058 - Plastic 2000 ml (4.2 pint) Container located not more than 1m (3.3 ft.) below the engine with a known good supply line.

New Engine Family (NEF; Family III) – Electronic Fuel Systems

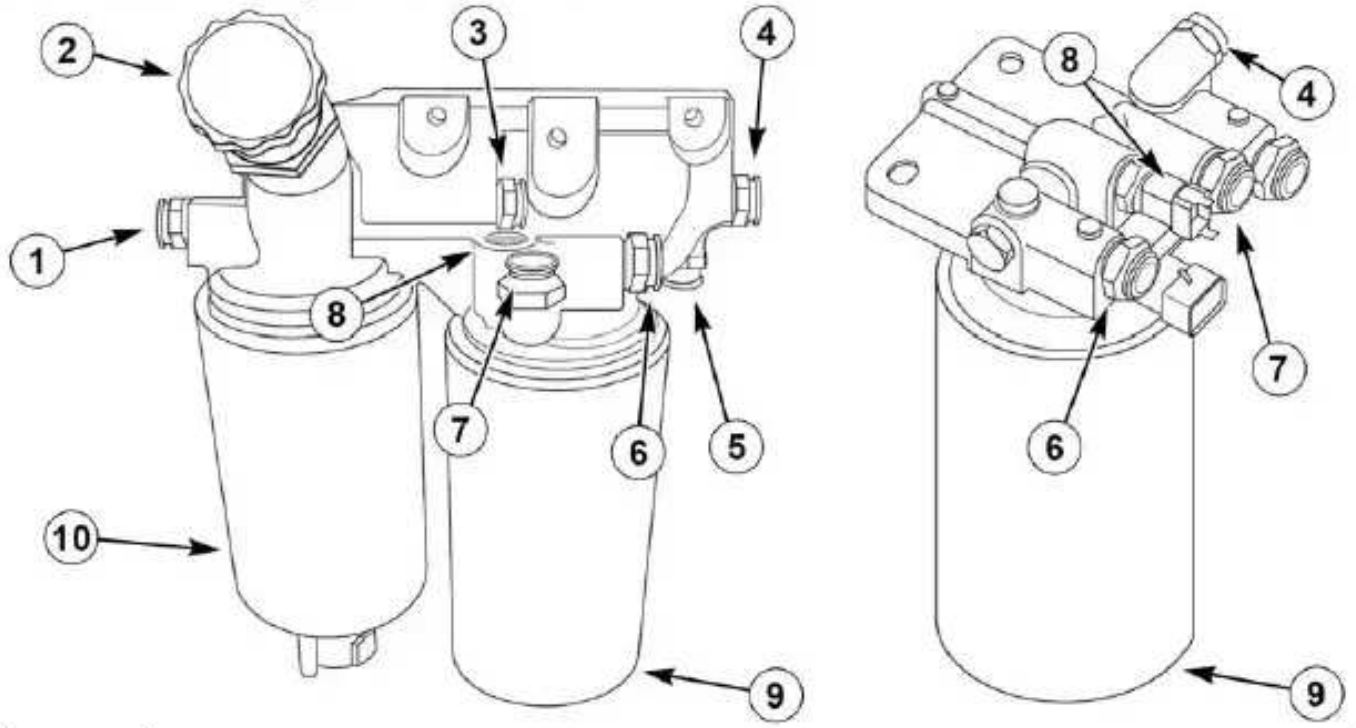
Introduction

CNH Electronic fuel systems all contain the same basic components but are built in many configurations. The following procedures include separate diagrams (where appropriate) for:

- Agricultural Equipment Applications - Dual Primary/Secondary Fuel Filter Assembly
- Construction Equipment Applications - Single Primary and Single Secondary Fuel Filters

O-rings and connections can be suspect for air ingress. Kinked lines and contamination can be the cause of excessive restriction.

Fuel Filter Assembly Port Identification



Item	Description
1	Fuel Inlet Port
2	Hand Primer Pump
3	Outlet from Primary Fuel Filter to Gear Pump Inlet (operates under vacuum)
4	Return Fitting for Cylinder Head (Injector and Connector) and Common Rail Relief Valve Return
5	Fuel Return to Fuel Tank
6	Outlet from Secondary Fuel Filter (operates under pressure)
7	Inlet to Secondary Fuel Filter from Gear Pump Outlet (operates under gear pump outlet pressure)
8	Fuel Temperature Sensor Location
9	Secondary Fuel Filter (operates under pressure)

10	Primary Fuel Filter (operates under vacuum)

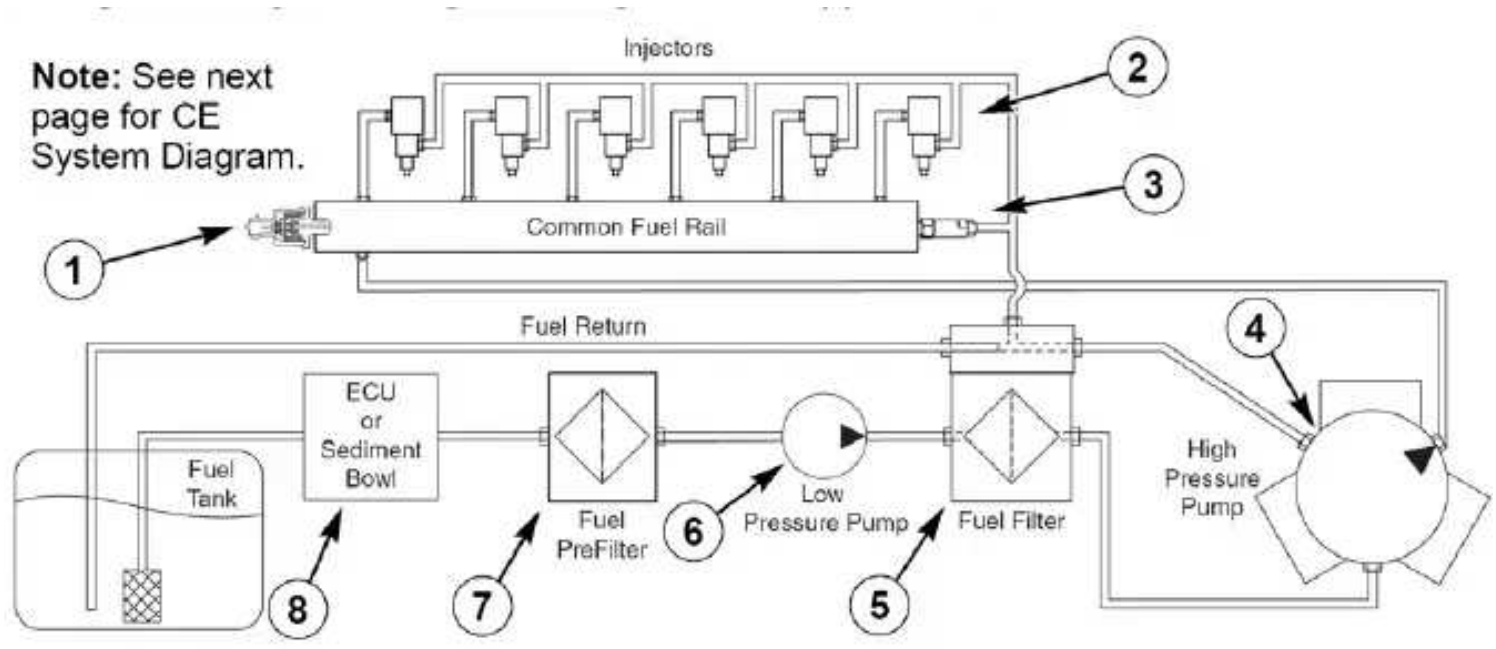
Section 4: Electronic Fuel System Description

The fuel injection system consists of:
The fuel supply, a pre-filter (if equipped), the Engine Control Unit (ECU), a low pressure fuel pump, fuel filter(s), a high pressure fuel pump, a high pressure flow regulator, a common fuel rail, a fuel rail pressure sensor, fuel pressure relief valve, fuel injectors, the necessary lines and connections.

Testing Specifications and Tips (reference Figure A or Figure B)

- Vacuum between the inlet of the low pressure pump and the tank should not exceed127 mm (5 inches) of Hg.
- Fuel supply pressures between the fuel filter and the inlet to the high pressure pump should be 5 bar (72 psi) minimum with the engine loaded or unloaded.
- Run multiple tests while observing fuel pressure and looking for air in the fuel.
- Perform a .wiggle test. on each fuel line. A steady stream of bubbles or foam should not be seen moving through the fuel system. Very small random bubbles are allowable.

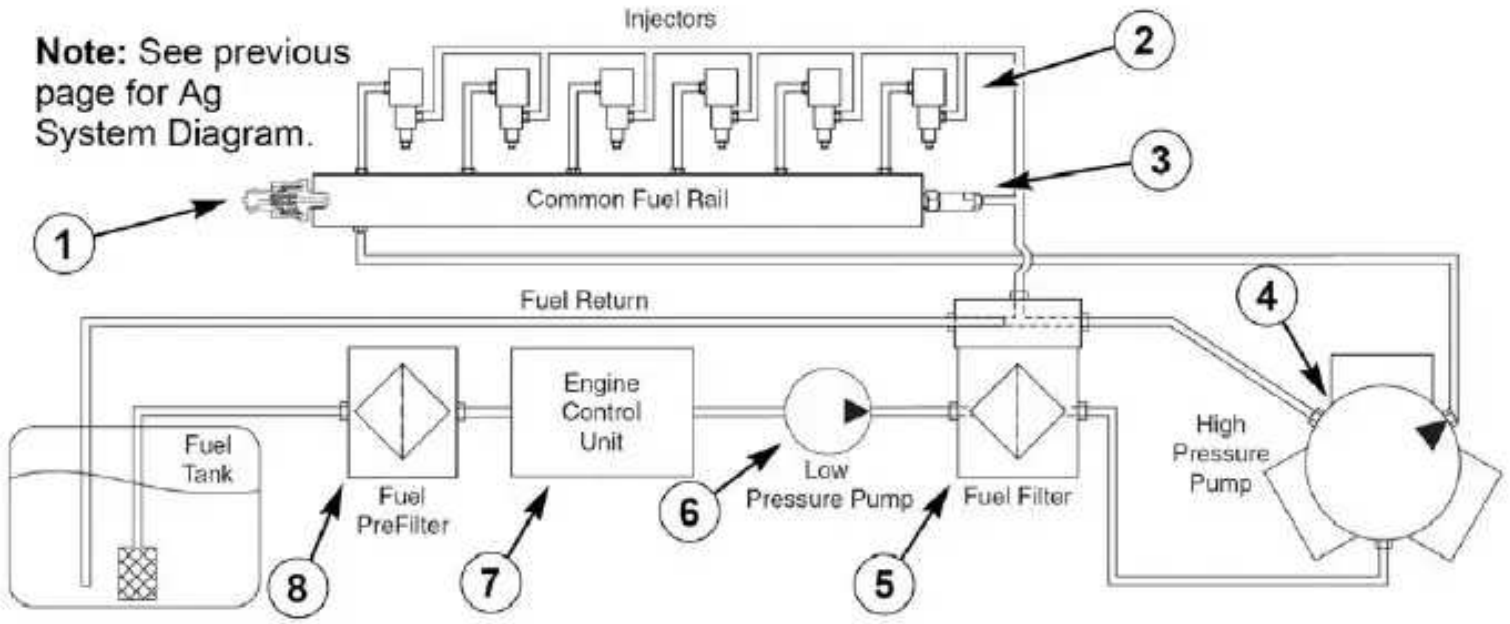
Figure A: System Diagram – Agricultural Applications



Item	Description
1	Pressure Sensor
2	Fuel Injectors
3	Pressure Relief Valve
4	High Pressure Fuel Pump with High Pressure Flow Regulator
5	Fuel Filter with Fuel Return Manifold Connections
6	Low Pressure Fuel Pump -This gear pump supplies fuel to the high pressure fuel pump. It is driven from the shaft of the high pressure pump
7	Fuel Pre-Filter (Primary Fuel Filter, if Equipped)

8	ECU/Sediment Bowl - Fuel is passed near the ECU for temperature control purposes or through a sediment bowl unit for fuel conditioning purposes.

Figure B: System Diagram – Construction Applications



Item	Description
1	Pressure Sensor
2	Fuel Injectors
3	Pressure Relief Valve
4	High Pressure Fuel Pump with High Pressure Flow Regulator
5	Fuel Filter with Fuel Return Manifold Connections
6	Low Pressure Fuel Pump -This gear pump supplies fuel to the high pressure fuel pump. It is driven from the shaft of the high pressure pump
7	Engine Control Unit (ECU) - Fuel is passed near the ECU for temperature control purposes.
8	Fuel Pre-Filter (Primary Fuel Filter, if Equipped)

Section 5: Fuel Inlet Restriction / Air Entering System

NEF Electronic Fuel Systems (reference Figure C or Figure D)

To determine if the low-pressure fuel supply is restricted, or if air is entering the system.

1. Install 380100056 at the inlet of the low pressure pump (after the primary filter).
   - This test line contains a compound gauge . 0 to 762 mm (0 to 30 inches) of Hg vacuum and 0 to 2.07 bar (0 to 30 psi) positive pressure. This test line is constructed with clear tubing to allow observation for air in the system.

   Install 380100057 between the outlet of the fuel filter and the inlet of the high pressure pump.

   - This test line contains a pressure gauge . 0 to 11 bar (0 to 160 psi).

   _____Operate the engine to purge air from the system which entered during gauge installation.

   Note: The clear line could be left in place over night to check for a slow air ingress leak.

2. When air is no longer visible in the clear test line, measure and record the operating pressure, while continually observing for air in the fuel. Fuel Pressure Specification between Filter and High Pressure Pump: 5 bar (72 psi) minimum. Conditions:

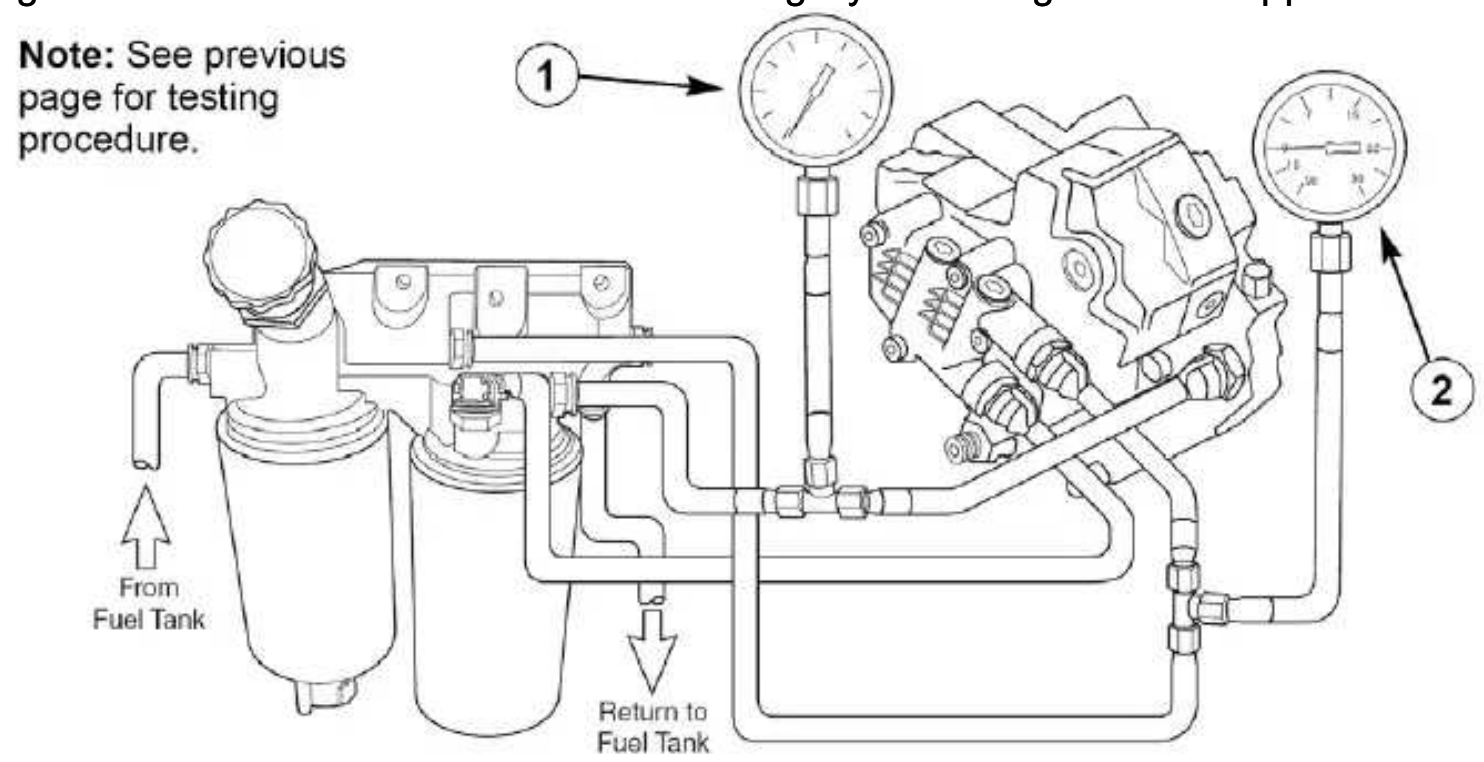
   _____Gauge 1 _____ Gauge 2: Low idle; apply no load to the engine.

   _____Gauge 1 _____ Gauge 2: 1500 RPM; apply no load to the engine.

   _____Gauge 1 _____ Gauge 2: High idle; apply load to the engine using the hydraulics (over relief), hydrostatic stall, converter stall, or dynamometer. Load the engine to its rated rpm.

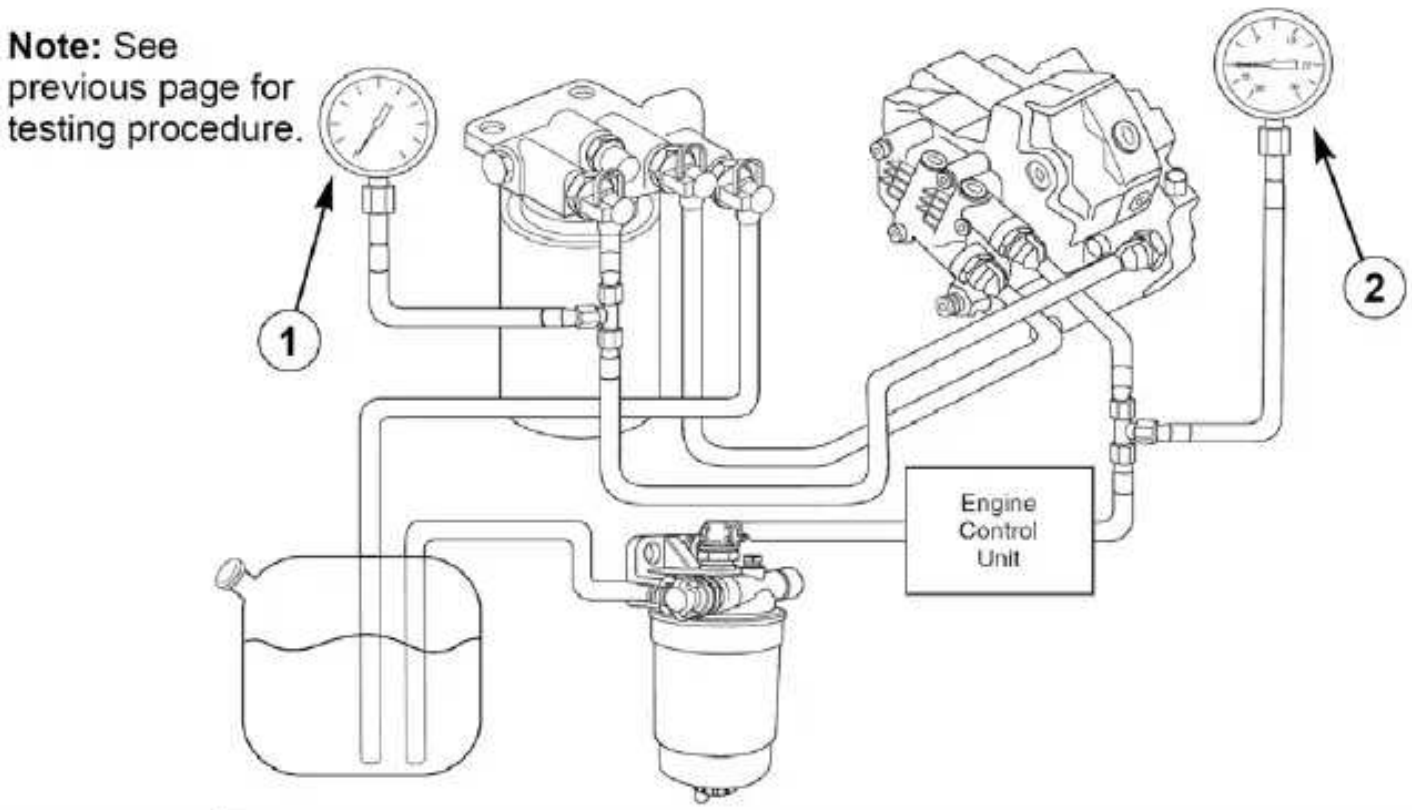
   Note: See next page for Fuel Inlet Restriction / Air Entering System diagrams related to this testing procedure.

Figure C: Fuel Inlet Restriction / Air Entering System – Agricultural Applications



Item	Description
1	380100057 - 0 to 11 Bar (0 to 160 PSI) Gauge and Hose Assembly
2	380100056 - 0 to 100 kPa/0 to 30" HG, 0 to 200 kPA/0 to 30 PSI Gauge Assembly

Figure D: Fuel Inlet Restriction / Air Entering System – Construction Applications



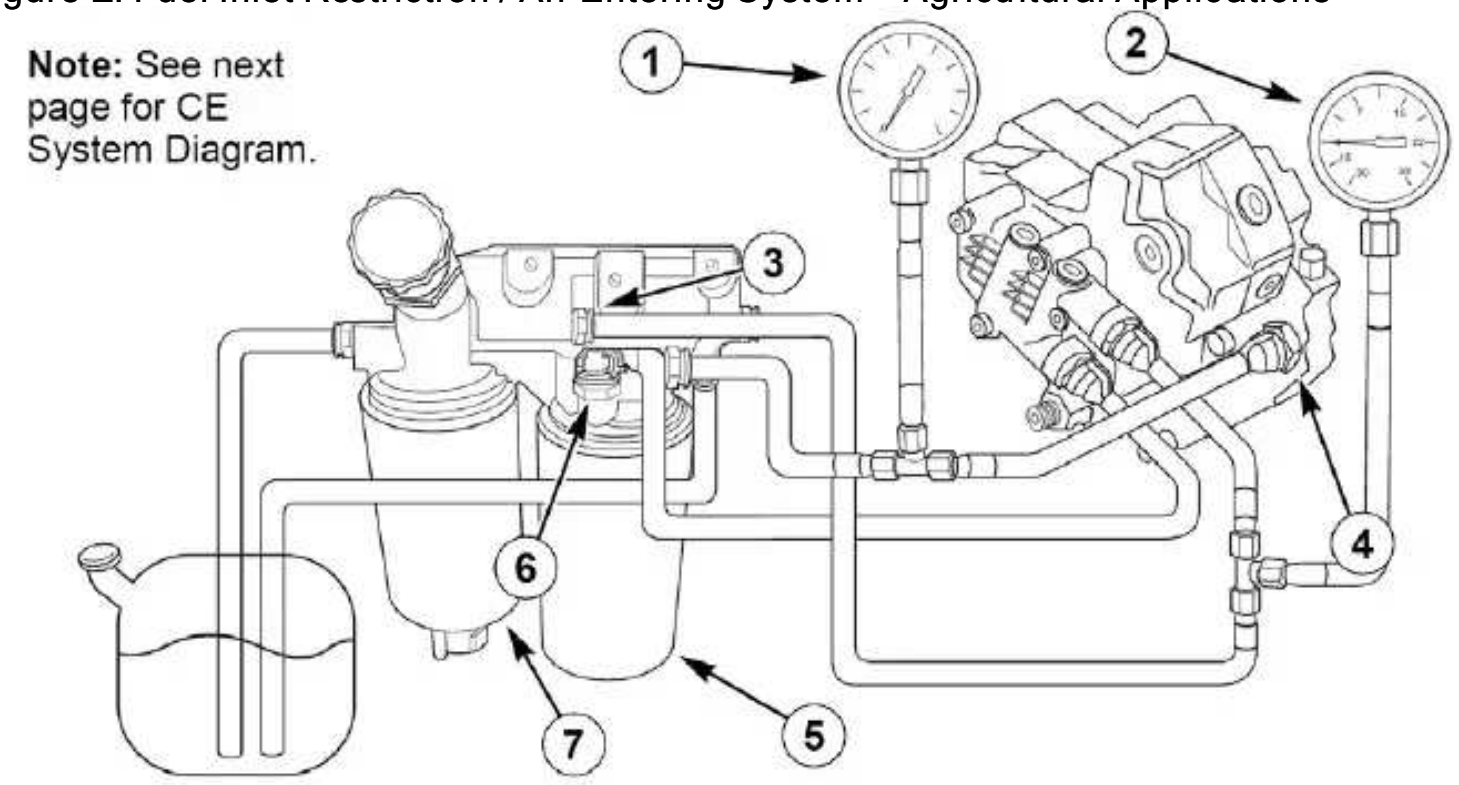
Item	Description
1	380100057 - 0 to 11 Bar (0 to 160 PSI) Gauge and Hose Assembly

2	380100056 - 0 to 100 kPa/0 to 30" HG, 0 to 200 kPA/0 to 30 PSI Gauge Assembly

Fuel Inlet Restriction / Air Entering System (Reference Figure E or Figure F)

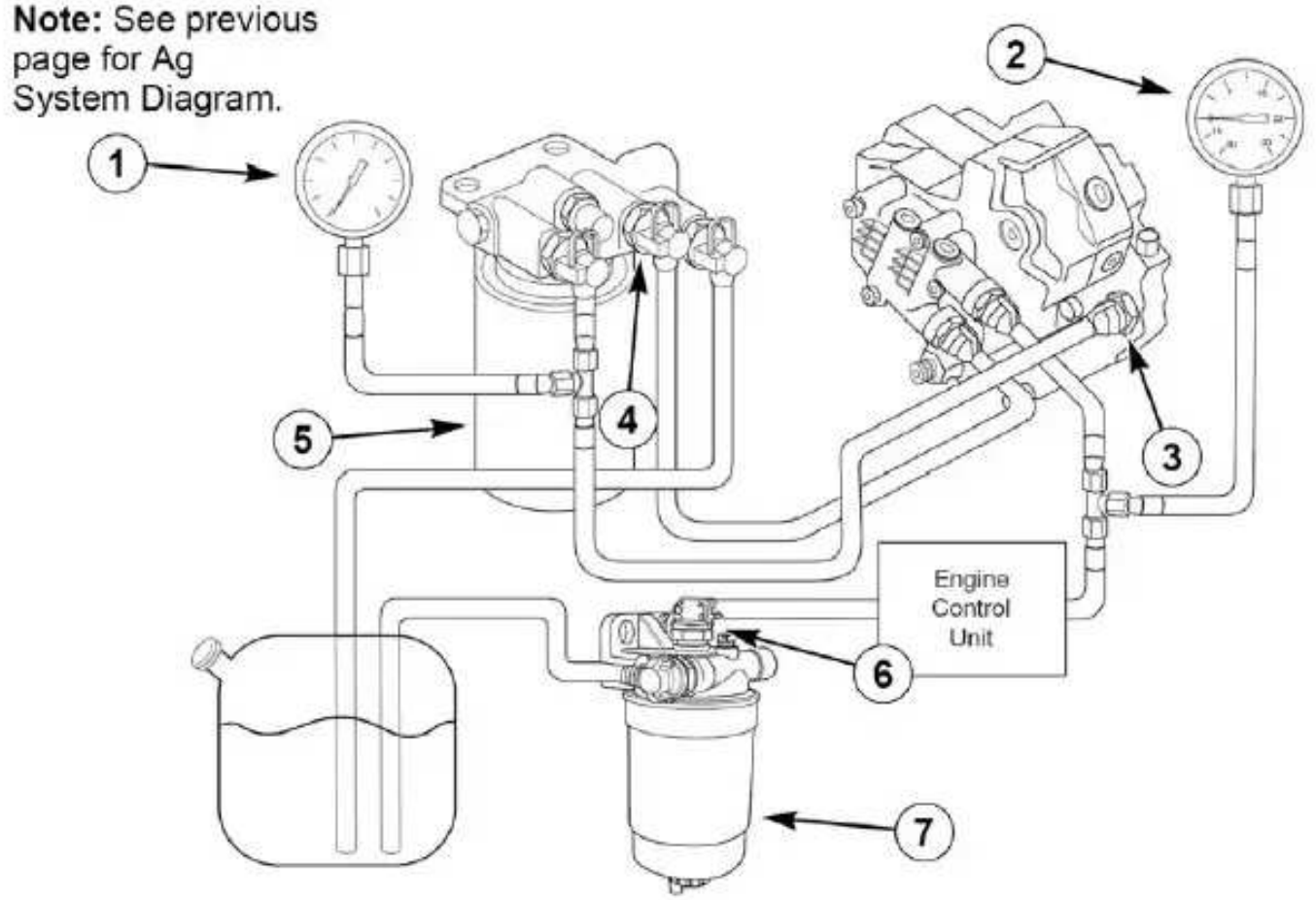
3. If the fuel pressure at gauge 1 is below 5 bar (72 psi) at any time during the test, check/ replace the following as needed:
   - Fuel Pre-filter (if equipped). Some applications do not use a fuel pre-filter.
   - Primary Fuel Filter
   - The lines and connections from the fuel supply pump inlet back to the fuel tank, checking for damaged lines (kinks create restriction; rub marks may allow air to enter) and leakage at the Voss o-ring fittings.
   - Fuel tank, clean as required.
   - The fuel pick-up tube in the fuel tank. Check for cracks, plugging, or contact with the bottom/sidewalls of the tank.
   - The fuel tank cap. Be sure a vacuum is not being formed in the fuel tank. A vacuum at the tank would reduce the fuel supply pressure to the injection fuel pump inlet. Vacuum in the fuel tank might not be observable during short-term running.
   - Check the valve at the fuel tank outlet (if equipped). Ensure that fuel supplied to and from the valve assembly is properly connected.

Figure E: Fuel Inlet Restriction / Air Entering System – Agricultural Applications



Item	Description
2	380100057 - 0 to 11 Bar (0 to 160 PSI) Gauge and Hose Assembly
3	380100056 - 0 to 100 kPa/0 to 30" HG, 0 to 200 kPA/0 to 30 PSI Gauge Assembly
1	Primary Filter Outlet to Low Pressure Pump Inlet
4	High Pressure Pump Inlet from Fuel Filter Outlet
5	Secondary Fuel Filter (pressurized filter)
6	Secondary Fuel Filter Inlet (pressurized filter)
7	Primary Fuel Filter (suction filter)

Figure F: Fuel Inlet Restriction / Air Entering System – Construction Applications



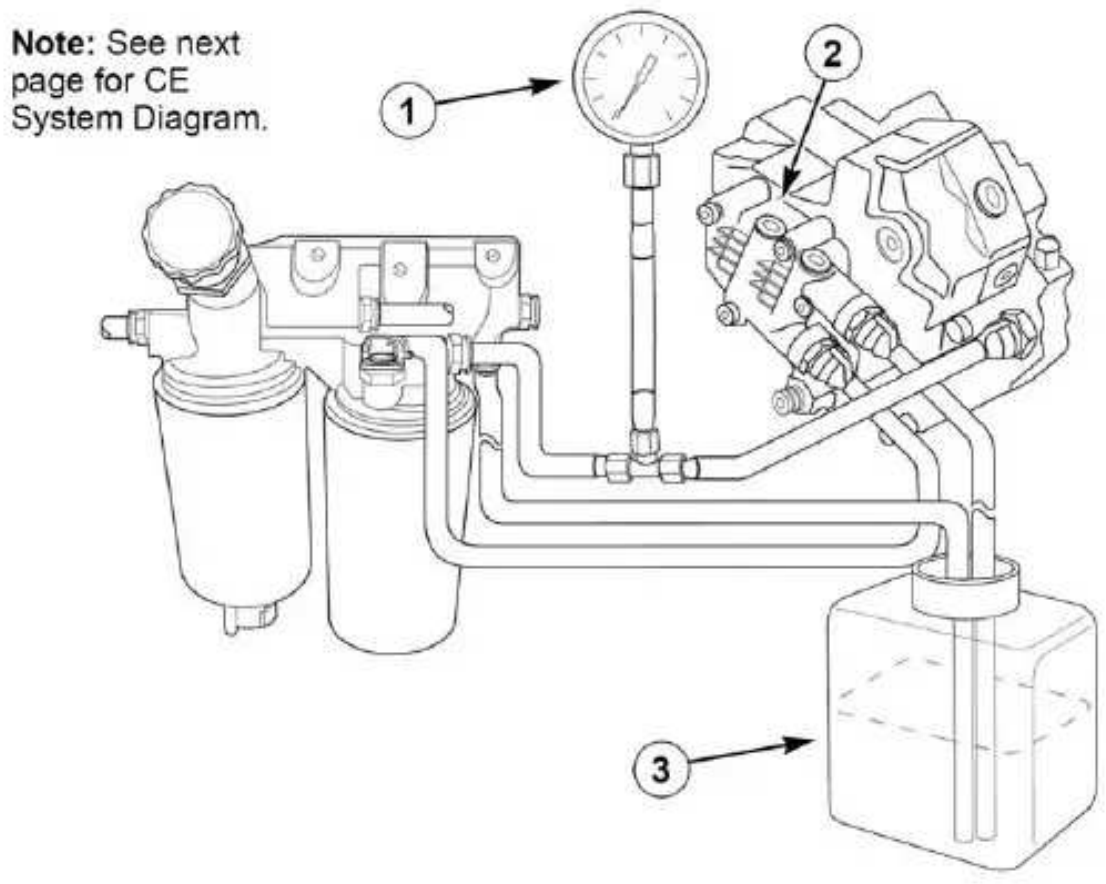
Item	Description
1	380100057 - 0 to 11 Bar (0 to 160 PSI) Gauge and Hose Assembly
2	380100056 - 0 to 100 kPa/0 to 30" HG, 0 to 200 kPA/0 to 30 PSI Gauge Assembly
3	High Pressure Pump Inlet from Fuel Filter Outlet
4	Secondary Fuel Filter Inlet (pressurized filter)
5	Secondary Fuel Filter (pressurized filter)
6	Primary Filter Outlet to Low Pressure Pump Inlet
7	Primary Fuel Filter (suction filter)

Section 6: Low Pressure Pump Testing

NEF Electronic Fuel System (reference Figure G or Figure H)

1. If the pressure is still low - 5 bar (72 psi) minimum, perform the following tests:
   - Supply fuel from an alternate fuel source (a separate container, 380100058), located not more than 1m (3.3 ft.) below the engine with a known good supply line. This bypasses: The Fuel Tank, Inlet Lines and Connections, and Pre-Filter (if equipped)
   - Connect a pressure gauge assembly (380100057) between the fuel filter outlet and the high pressure pump inlet.
2. The engine should start (at the first or second attempt) and then draw fuel from the external container. Check the fuel pressure at 1500 rpm. The reading on the filter outlet pressure gauge should be higher than 5 bar (72 psi). If the pressure is lower than 5 bar (72 psi):
   - Replace the fuel filter(s).
   - Retest. If the pressure is still below 5 bar (72 psi), replace the low pressure pump.
   - Retest. If the pressure is still below 5 bar (72 psi), the pressure regulator (part of the high pressure pump assembly) could be responsible, replace the high pressure pump.

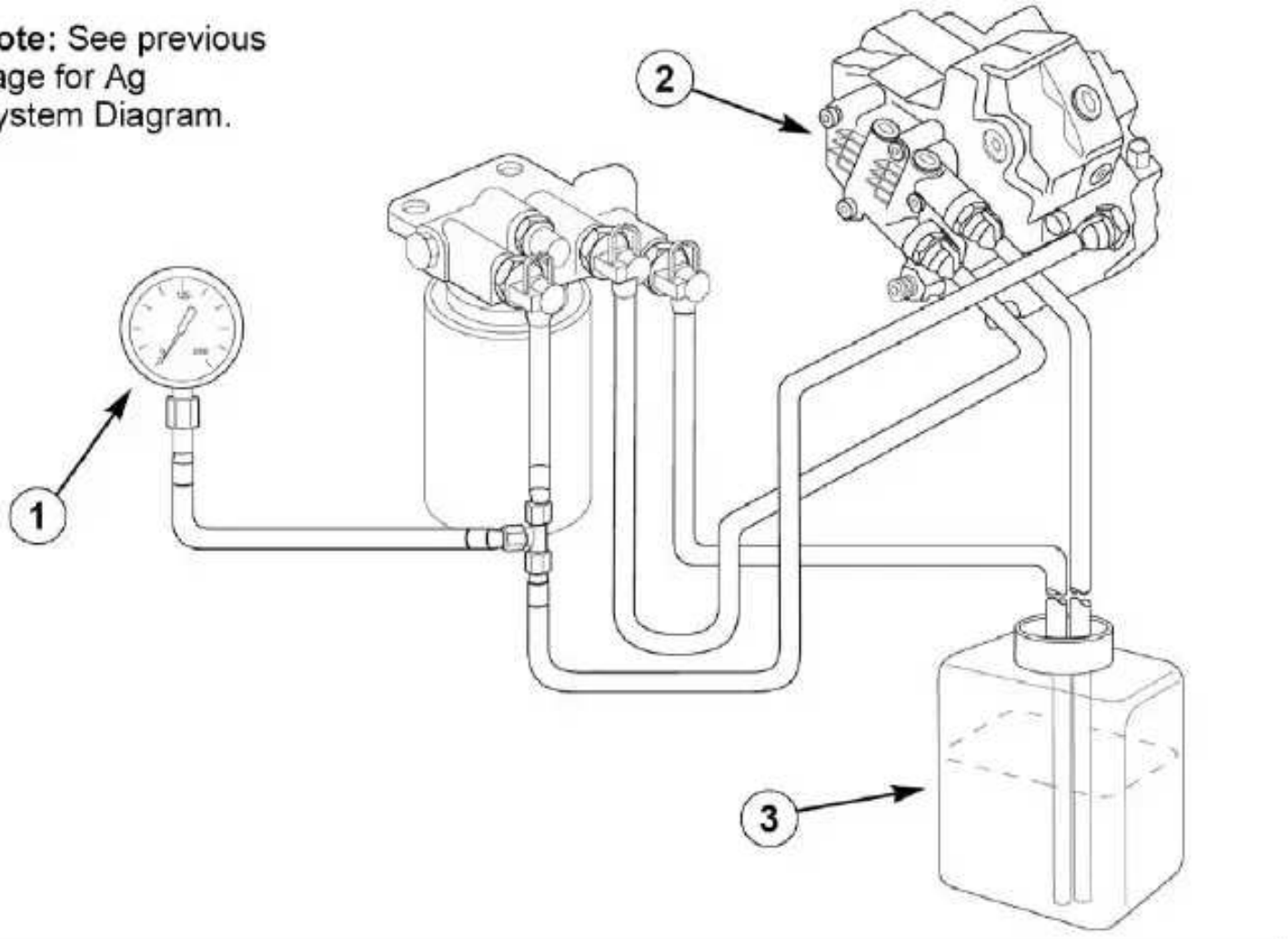
Figure G: Low Pressure Pump Testing – Agricultural Applications



Item	Description
1	380100057 - 0 to 11 Bar (0 to 160 PSI) Gauge and Hose Assembly
2	Low Pressure Pump

3	380100058 - Plastic 2000 ml (4.2 pint) Container

Figure H: Low Pressure Pump Testing – Construction Applications



Item	Description
1	380100057 - 0 to 11 Bar (0 to 160 PSI) Gauge and Hose Assembly
2	Low Pressure Pump
3	380100058 - Plastic 2000 ml (4.2 pint) Container located not more than 1m (3.3 ft.) below the engine with a known good supply line.

Section 7: Pressure Relief Valve Testing

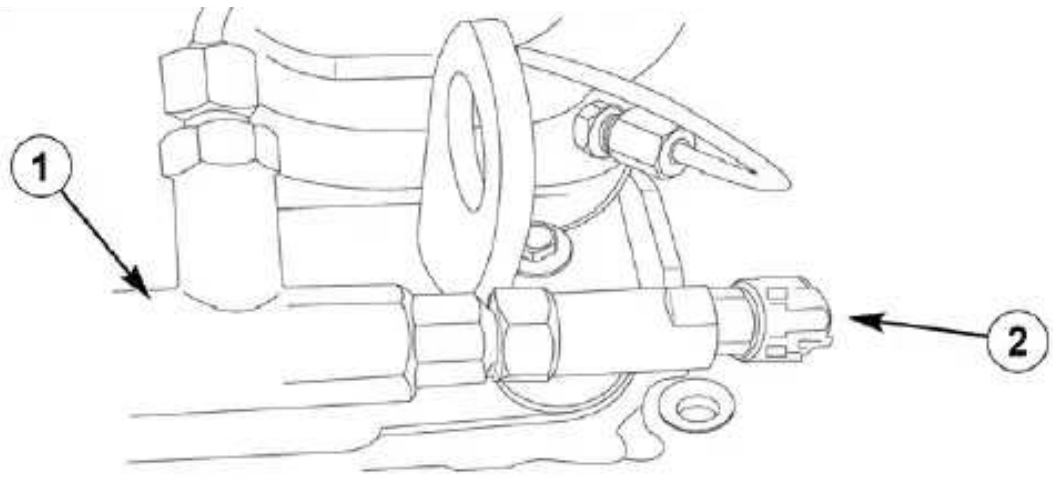
NEF Electronic Fuel Systems

The Pressure Relief Valve is located at rear end of the fuel rail. This pressure relief valve protects the fuel system components from excessive pressure if:

- The Rail Pressure Sensor fails to signal the correct pressure to the ECU (Engine Control Unit).
- The High Pressure Flow Regulator, located at the pump, allows excessive pressure in the high pressure system.
  Note: Fault codes listed apply to CE applications only.

1. Check the ECU for:
   - Fault codes related to over pressurization of the common rail, reference Section 8: High Pressure Flow Regulator

   Disconnect the pressure relief valve return line and cap the line with 380100060 cap. Install 380100057 gauge and hose assembly on the relief valve to direct any leakage to container 380100062 if the relief valve is leaking.
   Note: Under normal circumstances, fuel should not come out of the relief valve.
2. If the diagnostic system does not indicate a fault code and fuel is leaking from the pressure relief valve, replace the pressure relief valve.



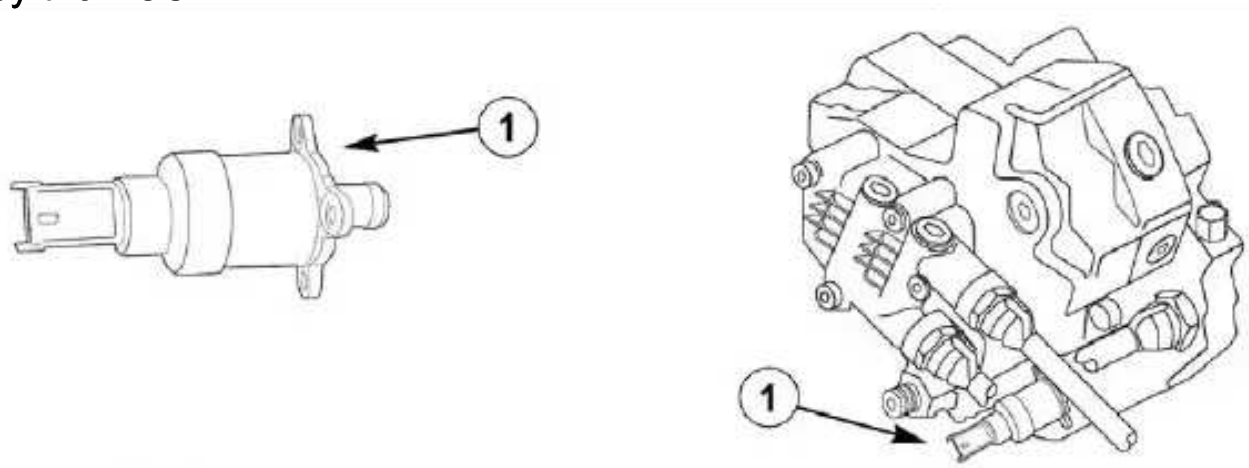
Item	Description
1	Fuel Rail
2	Pressure Relief Valve Return Line Voss Coupler (appearance varies)

Section 8: High Pressure Flow Regulator

NEF Electronic Fuel Systems

The High Pressure Flow Regulator is an electrical control located at the inlet of the high pressure pump. It regulates the amount of fuel supplied to the high pressure system based on control signals received from the ECU (by modulating the pulses sent to the internal solenoid). This is used to control the pressure within the fuel rail.

- The high pressure flow regulator is normally open.
- The high pressure pump is in maximum delivery mode if no control signal is sent by the ECU.



Item	Description
1	High Pressure Flow Regulator (Resistance Specification is 3.2 Ohms)

If the high pressure flow regulator has an open circuit (the flow regulator is disconnected, the harness is broken, etc) or a short circuit (resistance value is much lower than 3.2 Ohms follow the next steps:

1. The pump will be in maximum delivery mode and pressure in the rail will exceed 1700 bar (24,660 psi) for a very short amount of time.
2. The High pressure relief valve will open.
3. The ECU sense the over pressure condition and store fault codes in the ECU memory.
4. The engine will de-rate.
   - Check the resistance (on the ECU connector pins). The resistance specification is approximately 3.2 Ohms
   - When in parameter mode on the Electronic Service Tool, the duty cycle reading indicates the position of the regulator.

   Important: When all of the system components have been checked, inspect for the following symptoms:
   - The duty cycle tends to fluctuate irregularly and the engine idle speed is irregular.
   - The engine stalls when idling and no fault is stored in the ECU. Starting is difficult (takes longer than 4 seconds).

   Replace the high pressure flow regulator.

Section 9: Fuel Injectors

NEF Electronic Fuel Systems

Engine load and rpm are controlled by the fuel injectors. The load requested by the operator is controlled by the throttle position and converted into a fuel quantity by the ECU. The ECU controls the amount/timing of the fuel injection (using current fuel rail pressure as a factor).

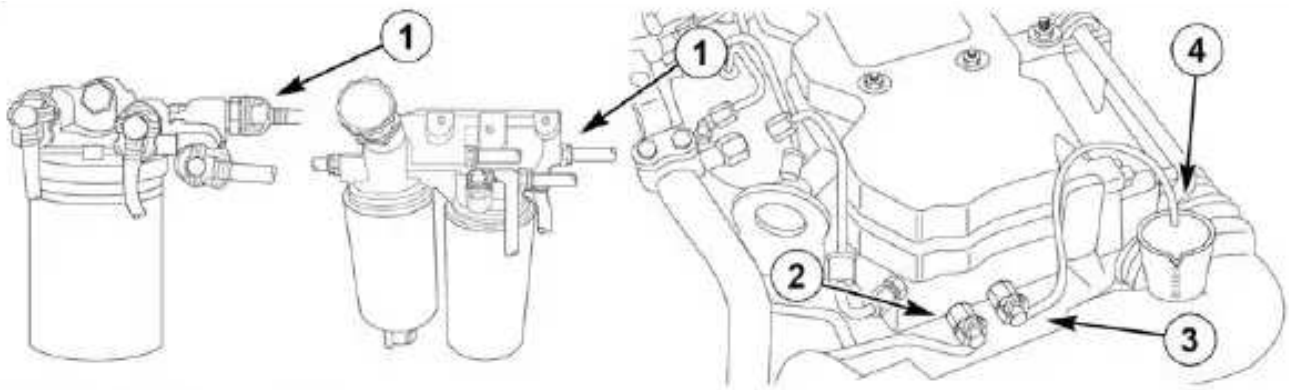
Fuel Injector Mechanical Problems

1. If the engine is difficult to start (excessive cranking time and no fault codes present):
   - Warm engine to 50° C (120° F) minimum. Check for excessive fuel return of the cylinder head injectors (with the engine running at low idle (no load - A/C etc.).
   - Complete A and/or B as required.

     Note: Return leakage can be checked at various locations (at the filter base or the cylinder head depending on ease of the connection. If excessive leakage is found, additional testing will be required to determine the exact location(s) of the leakage. Each fuel injector connector and the pressure relief valve could be a source of excessive return flow. More than one component could be responsible for excessive return.

   A. Disconnect the return line at the fuel filter base and plug (380100059) the filter port. Drain the fuel return line at the filter head into a 100 ml (3.4 oz.) cup (380100062) and measure the amount of fuel that escapes from the drain line in one minute. Leakage should not exceed 80 ml (2.5 oz.) per minute with the engine running at low idle. If leakage exceeds 80 ml (2.5 oz.), retest as directed in Step B to determine location of leakage.

   B. Disconnect the return line on the engine cylinder head and cap (380100060) the line. Connect a drain line (use 380100057 as a drain line) to the fuel return outlet on the cylinder head and measure the amount of fuel that escapes from the cylinder head port in one minute using a 100 ml (3.4 oz.) cup (380100062). Leakage should not exceed 80 ml (2.5 oz.) per minute with the engine running at low idle.

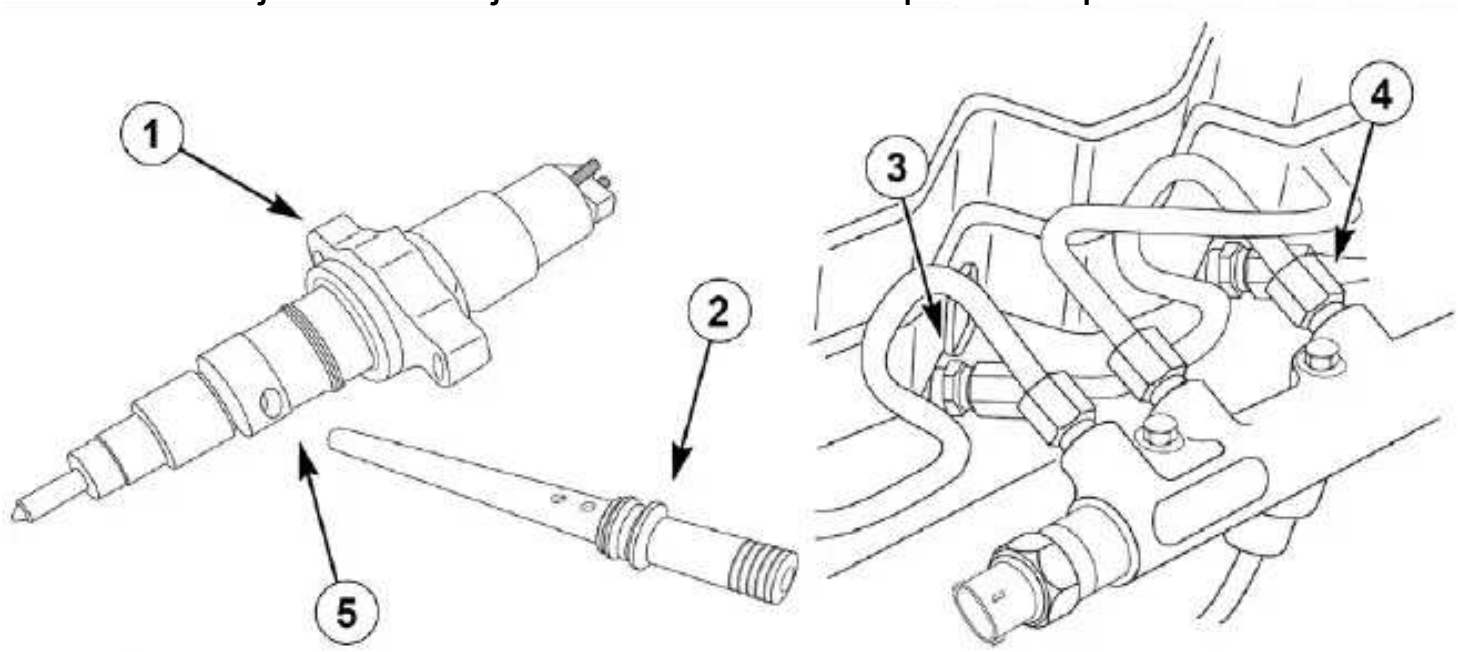


Item	Description
1	Return Line at Fuel Filter Base (style varies, disconnect and plug using 380100059)
2	Return Line Shown Disconnected and Capped (380100060)

3	Drain Line (use gauge and hose assembly 380100057 as the drain line) Shown Connected to Fuel Return Outlet on the Cylinder Head
4	100 ml (3.4 oz.) Cup (380100062)

2. If leakage from the cylinder head port exceeds 80 ml (2.5 oz.) per minute with the engine running at low idle, check the leakage within each injector.

- Maintain engine temperature, 50° C (120° F) minimum.
- To locate a damaged injector, cap (380100061) each fuel rail outlet location; one at a time. Recheck the total leakage. When the return leakage value drops significantly with a fuel rail outlet capped, a leaking injector has been identified. Replace the damaged injector. Retest total leakage to ensure additional injectors are not leaking excessively.
- Inspect the injector connector between each fuel injector and the associated fuel rail line. The torque specification is for the injector connector is 45 - 55 Nm (33 - 41 lb-ft). Check the fuel injector end of the connector to make sure is not deformed. If the injector end of the connector is deformed, replace the injector connector.
- If the injector supply tube is not the cause of the leakage, the injector may have internal leakage and require replacement. Injectors could leak excessively at operating temperature and perform correctly cold. Test kits 380040185 and 380040188 can be used to bench test injectors.
  Note: Injectors and injector connectors are replaced as pairs.



Item	Description
1	Injector
2	Injector Connector - Check the fuel injector end of the connector to make sure is not deformed.
3	Injector Connector Cylinder Head Location - Torque Specification is 45 - 55 Nm (33 - 41 lb-ft)
4	Fuel Rail Outlet - Cap (380100061) each fuel rail outlet location; one at a time.
5	Interface Location Between Injector and Injector Connector